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# SIXTY-FOUR JOINT MICE IN THE SHOULDER

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Sixty-four joint mice in the shoulder were the sequela of minor football injuries, at first neglected, and later submitted to ill advised osteopathic treatment, without preliminary x-ray examination, in the case of an active young civil engineer on whom the author recently operated.

As with all healthy individuals, who attribute but slight significance to occasional aches and minor injuries, it was difficult to elicit an accurate history. The patient (W.S.A.) is at present thirty-three years of age. About thirteen years ago, while playing football at college, he fell with his whole weight on the left shoulder. As the patient expressed it, he missed landing on top of someone he intended to. Accepting it as one of the normal bangs of a game, he was not conscious of any unusual injury. The trainer rubbed him down as usual after the game. Nothing else was done until two weeks later, when the arm, proving troublesome, was strapped to his side. Nevertheless he continued to play.

The arm gave no further trouble until spring training was started in 1914. The stiffness and occasional pain were then, however, attributed by both athlete and coach to lack of strenuous use throughout the winter season. But as some limitation of motion persisted, and the arm did not have the strength it used to, the advice of an osteopath was sought.

No x-rays were taken. The arm was manipulated, but not violently. The more important part of treatment, as the patient interprets it, was an exercise which was prescribed for frequent performance, namely "climbing up the wall" with the injured arm to increase the power of extension. The patient was instructed to stand against the wall, and reach higher and higher with the afflicted arm until fatigued. This would loosen up the joint, according to the osteopath. It proved sufficiently efficacious so that he played in every game that spring, and continued prominent in athletics throughout his college career.

"I had no further trouble that was great enough to keep me out of games." Closer questioning elicited admission of occasional pain, and limitation of motion, greater at the opening of a season, when violent exercise was resumed after the winter's lay-off, and growing less as the season wore on.

"It bothered me most, and has up to the present, when I sit with my arms folded, as in the theatre. Pain and throbbing would then start up to such a degree as to make me extremely wrigglesome and self-conscious by the middle of the second act."

Because of this socially annoying circumstance, and a natural curiosity to find out

why the arm was not only weaker than the other but persistently limited in motion (though not markedly so), this young man last year consulted his family physician, who took an x-ray,—the first to be taken. This was twelve years after the original injury.

After graduating from college and going into business, he had continued athletic to the extent of playing tennis and golf, and swimming. During the war he had participated in several football games and boxing matches, but gave up the latter because his left arm was "not a very good guard".

The family physician, after examining the x-ray, pronounced the condition unusual, and one with which he was not familiar, and referred the patient to the author for consultation. The patient, however, put this off until "a convenient time". "The arm was not really troubling me; it was just annoying, particularly when sitting for some time, with the arm inactive."

FIG. 1

Pre-operative x-ray, showing joint mice.

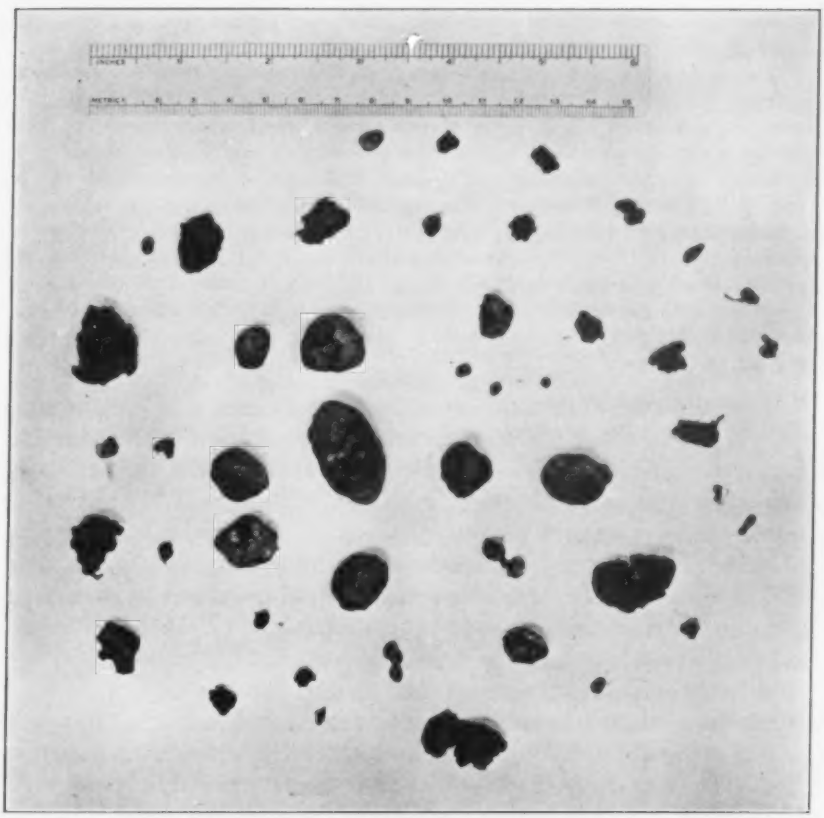

FIG. 2
Specimens showing variety of size and form of joint mice.

Several months later, and three or four days after returning from a strenuous business trip, a steady throbbing pain and burning in the shoulder, so intense as to keep the patient awake for three successive nights, brought the patient to the author with his x-rays.

"I do not know what started the intense pain. I had a cold at the time, and the day after I returned from Chicago, a Western Union messenger, running down the street, collided with me, hitting my left arm with considerable force. After this it began to pain, and just to prove it was all right, I tried to swing a golf club that evening."

Examination revealed limitation of motion in the left shoulder, and strength less than that of the other arm. The patient is subject to colds and grippe, but otherwise enjoys excellent health.

The x-rays showed unmistakable joint mice, and their removal was recommended.

Operation was performed March 3, 1927, at Postgraduate Hospital, and sixty-four joint mice were removed.

## OPERATIVE FINDINGS

The sixty-four flattened ovoid bony masses varied from 2 mm. in diameter up to 3 x 2 x 1.5 cm. Most of the "mice" were creamy white, and smooth except for frequent pitting. Some, however, were grayish red, the surface highly irregular, and studded

with small, rounded bony excrescences. A roughened portion was usually detected, indicating where the nodule had been torn from its base.

The pathologist's diagnosis was "chronic cartilaginous and osseous synovitis with production of free bodies or joint mice". Microscopic sections were made from two representative nodules. One of the smooth variety was found to consist of hyaline cartilage, irregularly arranged, and undergoing necrosis and liquefaction as well as calcification. Peripherally there was evidence of sluggish proliferation of the cartilage. In one small place the cartilage was being replaced by bone. A section through one of the more irregular masses showed slender, irregular trabeculae of bone with extensive fatty marrow spaces. The periphery of the nodule was formed by a layer of fibrous tissue which in places seemed to be pinching off portions of the bony structure. Occasionally cartilage merged with the superficial bony trabeculae and with the fibrous capsule. Rarely a small bit of granulation tissue containing endothelial leucocytes was found. (Ward J. MacNeal, pathologist).

Joint mice in the shoulder are comparatively rare. This is the second case which has come under the author's observation. They are most commonly found in the knee, probably because of the frequency with which this joint, with its peculiar anatomy, is exposed to trauma and strain. On two occasions the writer has removed joint mice from the elbow, and he has seen a few cases complicating arthritis of the hip.

The discomfort and burning complained of by this patient may have been due to an infectious element superimposed upon the presence of the joint mice, as evidenced by the extensive amount of fluid in the joint.

A sharp spicule of bone was found on the anterior aspect of the head of the humerus, which was removed by osteotome and mallet. The synovial membrane was much thickened and extensive vascular changes were noted. These findings, together with the unusual quantity of clear, slightly turbulent fluid, evidenced the chronicity of the synovitis.

As the capsule was considerably distended by the large number of joint mice, it was necessary to plicate it with interrupted sutures of medium kangaroo tendon and immobilize the arm in bandages for two weeks in order to allow the capsule to shrink to normal size, thus obviating the possibility of future dislocation. Removal of the bandages was followed by massage.

At present the patient has good function in the arm, and is free from pain. A recent x-ray, however, shows five joint mice, apparently pedicled and in a pocket at the extreme lower angle of the joint.

# THREE CASES OF TABETIC CHARCOT'S SPINE

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Neuropathic arthropathies of the spine accompanying tabes dorsalis, while not as rare as was originally believed, are sufficiently uncommon to merit reporting.

## CASE REPORTS

CASE 1. An Austrian, forty-nine years old, was seen January 12, 1923, because of increasing deformity of the left ankle. Shortly after finishing his service in the Austrian army he came to this country where he worked fairly constantly in the coal mines. His usual health and strength had been good; he had had no severe illnesses since childhood and no operations. He denied syphilis by name and symptom. His first child was born dead at eight months; his second child died at three months; all of his first six children were dead; eight subsequent children were living and well. (The youngest was seen about a year later and showed obvious stigmata of congenital syphilis.)

Twenty-six years ago his right foot was so severely mashed by a fall of stone that he could not work for fourteen months and since that time had shown some deformity which had become more marked in the last few years. Eleven years ago he ran into a live wire and was knocked down. The shock did not seem to be very severe, but about eight days later he noticed that he saw double and that his left eye turned in. At first this was slight and transitory but gradually became more marked so that for five years his eye turned in all the time. Ten years ago he was squeezed through the lower back and hips between a pit-car and a rib of coal and was unable to work for six months. Since then he had had some pain and weakness through the small of the back. About five years ago, he noticed the gradual appearance of a lump over the lower part of the spine which slowly increased in size but did not materially interfere with his work. Seven years ago he fell, fracturing his left ankle. The swelling and deformity persisted. Five years ago he sprained the same ankle pushing a pit-car and could not work for five months. Four years ago his left heel caught in a switch and one of the wheels of a pit-car ran up on the inner side of the foot. Since then his ankle had grown progressively worse and he had been unable to work. For six years he had noticed that his vision had been gradually failing; for four years he had had more or less dizziness; for two years he had had sharp, stabbing transient pains in his legs, particularly when tired and during changes in the weather; for a year he had had similar pains through his abdomen, and noted considerable diminution in his sexual power and desire.

He was a large, well developed and nourished man of about fifty, walking with the aid of a cane. His gait was distinctly unsteady. There was left internal strabismus. The pupils were irregular, unequal and showed no reaction to light; the left pupil showed a very sluggish reaction to accommodation, the right none. All the tendon reflexes were absent. Pain sensation was markedly diminished and delayed over the legs and feet, slightly so over the thighs and forearms. Touch was also somewhat diminished over the legs. Testicular sensation was markedly diminished. Coordination in both the upper and lower extremities was considerably impaired. Romberg's sign was strongly positive. The lumbar region of the spine was slightly shortened and in the central portion presented an acutely rounded, almost angular kyphosis with slight left scoliosis. Palpation showed marked, hard, non-tender thickening about the vertebral bodies, most marked in the mid-lumbar region. This portion of the spine was fixed, but the mobility of the entire spine was greater than normal, so that in bending he almost

FIG. 1

Case 1. An old, advanced process. There is involvement and destruction of the second and third lumbar vertebrae with compression, rotation and scoliosis. The intervertebral spaces are obliterated. Large purposeful osteophytes bridge the affected vertebrae and so lend support to the involved portion of the spine. These are fairly well smoothed off and show mature osseous content.

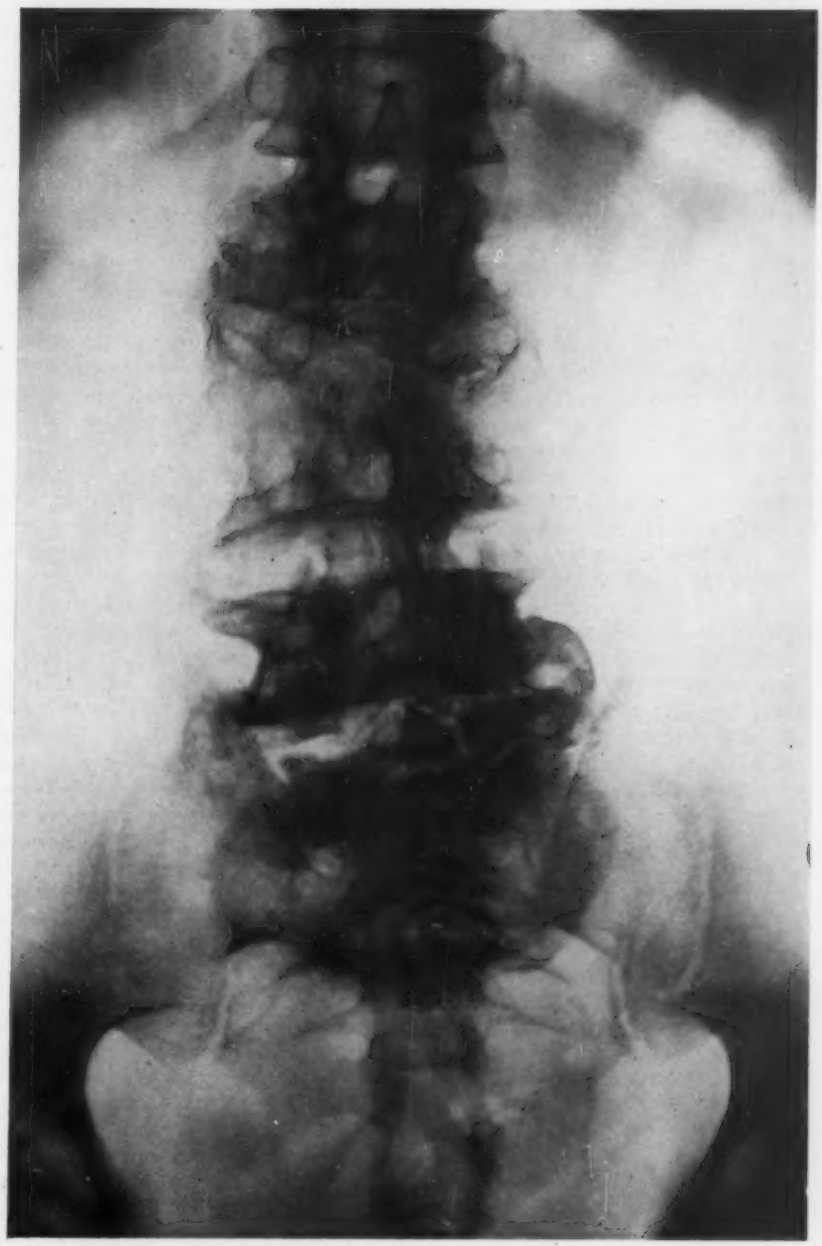

FIG. 2

Case 1. The same spine about four and a half years later. There has been some progress in the original lesion. In addition, there has been extensive destruction of the fifth lumbar vertebra which has practically disappeared except for its transverse and spinous processes. The upper portion of the sacrum is also eroded.

seemed to have a hinge in the lumbar spine. Active motion was not accompanied by muscle spasm or complaint of pain. There was great deformity of the left ankle and foot. Palpation revealed marked irregular bony thickening. All the bony landmarks were obliterated. The foot was everted and displaced laterally, and the lower end of the tibia displaced downward and forward. There was marked stiffness and limitation of all motions, and on manipulation grating and what were apparently small loose fragments of bone could be felt. The right ankle showed a similar but much less marked condition. Very active manipulation of both ankles did not cause complaint of pain. Blood Wassermann was negative. Spinal puncture was not done. X-rays of the ankles showed practically complete disorganization of these joints with many large, irregularly shaped, amorphous masses of bone from which several loose fragments had been detached. The x-ray findings in the spine are shown in Figure 1. This case is of additional interest because of the presence of three neuropathic arthropathies.

Subsequently, there was steady progression in his instability so that when seen again in May, 1927, he had great difficulty in getting about with the aid of crutches. He could not stand erect without support. While part of this was attributable to the increased incoordination of his tabes, most of it was due to disorganization of the lumbar spine. When support was removed, his muscles were no longer able to hold him erect and he immediately flopped over.

Case 2. An Austrian, aged forty-seven, married and employed as a coal miner, was referred for examination on June 4, 1923, because of an alleged back sprain. He had served in the Austrian Army for three years. He denied syphilis by name and symptom. His past history was unimportant; his wife had never been pregnant. On May 18, 1923, while lifting a pit-car on the track, he felt pain through the lower part of his back, quit and walked out. Since then, the pain had persisted. It was dull, boring in character and tended to radiate down the outer and posterior surface of the right thigh. It was increased by exertion, particularly forward bending, and relieved by recumbency. However, it was very bothersome at night when he was unable to find a comfortable position.

He walked with a slight right limp. His pupils were unequal, slightly irregular, and reacted sluggishly to light, normally to accommodation. The patellar and Achilles' reflexes were absent. His gait was distinctly ataxic with his eyes closed. Pain sensation was diminished over the lower portions of the legs. Testicular sensation was markedly diminished. The spine showed a sharp kyphos extending from the eleventh dorsal to the third lumbar spines. Movements of the spine were normal except that the segment involved by the kyphosis was fixed. Straight leg raising on the right was slightly limited. Blood Wassermann negative. Spinal fluid slightly bloody, Wassermann four plus, colloidal gold 5555400000. The x-ray findings are shown in Figure 3.

Case 3. An American, thirty-eight years of age, married, and a farmer. Twenty years ago, he had a chancre followed by a slight rash over his chest for which he took mercury by mouth for two years. Ten years ago, he began to have sharp, shooting pains in both legs. Eight years ago, he developed a severe diarrhoea which lasted a year and a half and caused him to lose one hundred pounds. During this time he began to have acute attacks of severe nausea and vomiting without pain. There was complete absence of sexual power and desire. At this time a slightly positive blood Wassermann was found and a spinal fluid examination was said to show syphilis. During the next four years he took twenty-five injections of arsphenamine and mercury almost continuously, with very little improvement.

When seen first, in 1922, he showed unequal, fixed pupils, absent tendon reflexes, incoordination and delayed and diminished pain sensation. Blood Wassermann, three plus. Spinal fluid Wassermann four plus, globulin slightly increased, fifty cells and colloidal gold 1111100000. Examination of his back showed nothing abnormal. During the next two and a half years, he received thirty injections of arsphenamine and neoarsphenamine and mercury intramuscularly with a good deal of general improvement, but without much change in his tabetic manifestations or spinal fluid findings. His

FIG. 3

Case 2. A relatively early process involving chiefly the first lumbar vertebra. There is destruction of the space below it with tilting and rotation. There has not been much bony destruction but already osteophytes have produced ankylosis. Elsewhere are the smaller osteophytes of chronic arthritis. In the lateral picture the interspaces above and below the first lumbar vertebra are obliterated so that the bodies of the twelfth dorsal and first and second lumbar vertebrae appear as a solid cylinder of bone.

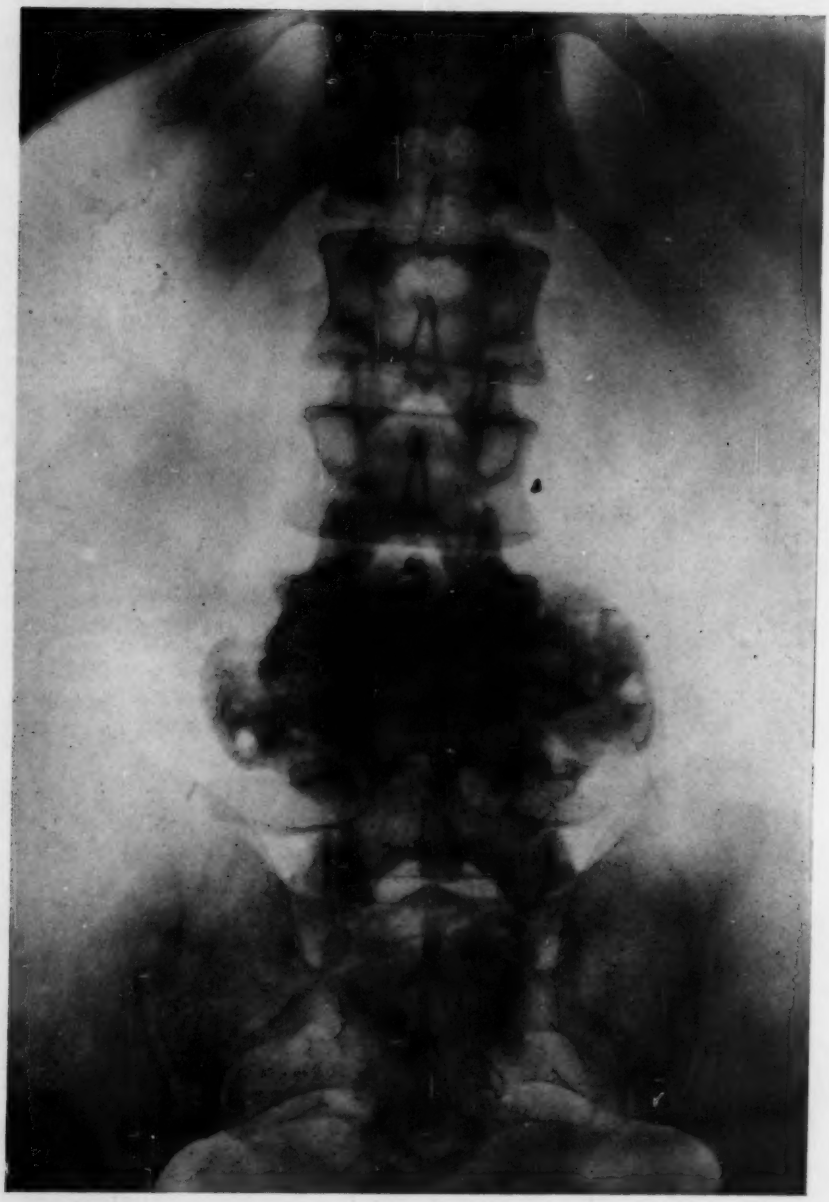

FIG. 4

Case 3. A typical neuropathic arthropathy involving chiefly the fourth lumbar vertebra which is almost completely destroyed. There are enormous proliferating osteophytes on either side. Each of these shows a rounded hole, apparently the opening for the spinal nerve.

gastric crises were particularly distressing. In the fall of 1924, a Swift-Ellis intraspinous treatment was given without improvement. In January 1925, he was started on tryparsamid. In the next eighteen months he received sixteen such injections with complete control of his gastric crises and marked lessening of his lightening pains.

In the fall of 1926, he had marked lameness and weakness in his left leg, lasting about a month. A little later he noticed a painful catch in his lower back when he turned over in bed and with this he would have a good deal of pain, radiating generally into both legs. A little later he noticed that his back tired, that it was irksome to sit or stand very long and that jolting caused a dull ache and soreness in the lower back with pain radiating into both legs.

Examination of his back at that time showed shortening of the lumbar spine and a sharp kyphos with its greatest prominence over the fourth spinous process. There was only slight tenderness and motions were free and easily made. In fact, he said he could bend over further than ever before. There was no definite evidence of nerve involvement. The x-ray findings are shown in Figure 4. A Taylor back brace was applied with considerable relief.

## COMMENT

Most of the neuropathic joint lesions of tabes occur in the lower extremities. As a rule, the condition comes on quickly and without pain. The first change is usually a great accumulation of fluid in the synovial sac with relaxation of the joint capsule and ligaments and marked enlargement of the joint. Later the synovial membrane is thickened and areas of osteitis and periostitis appear in the bones. Finally, the thickening involves the entire joint capsule and ligaments and the bones show a combination of degenerative and proliferative changes. The degenerative changes usually predominate with erosions, osteoporosis, osteosclerosis and atrophy of the ends of the bones. The proliferative changes result in bony growths or osteophytes about the articular margins and varyingly distributed plaques and irregularly shaped amorphous masses, often of considerable size. Frequently, some of these become separated as a result of tiny fractures and appear as detached bony fragments. These proliferative changes are generally of two types. The first is purposeless and is represented by the irregular, more or less amorphous masses which so frequently become fractured and detached. The second is purposeful and shows good osseous markings and integrity. They spring from the articular margins and may even be connected with the adjacent bones and tend to strengthen the disorganized joint by producing some degree of ankylosis. They resemble greatly the formations of chronic arthritis but are larger and better developed. The cause of these pathological changes is undoubtedly infection with the spirochaeta pallida, but whether the chief lesion is in the cord, the peripheral nerves, or the joint structures is still unsettled. Cord lesions are undoubtedly always present, but it seems probable that there are also actual syphilitic changes in the bones as well. The poor blood supply in the affected parts may account for the frequent negative Wassermann reactions. In some cases, trauma is undoubtedly a predisposing factor.

Charcot's spine, like similar manifestations in other joints, usually develops rather quickly and painlessly. Pain, when present, shows the

characteristics of syphilitic pain elsewhere, that is, it is nocturnal, persistent and distressing. Although the lesion itself is usually painless, with its later development there frequently appear characteristic root pains due to impingement of the nerve roots by displacement and proliferative changes. The initial change seems to be a simple breakdown of one of the lateral articulations of the vertebral body associated with a decrease in the cartilaginous space. As the bony destruction continues, there is compression of the vertebral body with displacement posteriorly and laterally. Usually the process is limited to one or two or three vertebrae so that the deformity is localized and acute. Proliferative changes are abundant and almost always purposeful in character, so that the affected region of the spine is frequently ankylosed. Separated fragments such as are seen so frequently in the knees and ankles are rarely seen in the spine. The local findings are characteristic. In addition to more or less swelling and infiltration, there is usually a sharp kyphos with more or less lateral curvature and rotation and some shortening due to compression. The involved section of the spine is usually rigid, due to ankylosis by bony deposits. However, the movements of the entire spine are usually normal or even increased by the local disorganization, so that the patient may flop about. There is practically no tenderness and no involuntary muscle spasm.

The diagnosis of Charcot's spine rests upon the manifestations already mentioned, occurring in the presence of the usual evidences of tabes. One of the most characteristic features is the disproportion between the severity of the process disclosed by the x-ray and the slight discomfort and disability complained of by the patient.

# THE DIAGNOSIS AND TREATMENT OF ARTERIAL VASCULAR DISEASE OF THE EXTREMITIES*

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In the mind of the patient, and often in the mind of the physician, pain in the feet is synonymous with lesions of the bone or joints, arch relaxation or other static disturbances. Insomuch as many such disorders ultimately come to the attention of the orthopaedic surgeon, it is necessary that he have a clear conception of vascular diseases of the extremities and so be prepared to make the differential diagnosis that is so necessary for rational treatment.

Vascular occlusion in its incipient stages lacks clear-cut signs; the symptoms are usually pathognomonic but frequently erroneously interpreted. Investigation of the condition of pulsations in the peripheral arteries is usually neglected and the possibilities of a vascular basis of the patient's complaints are not considered until one of the major signs of arterial insufficiency appears as trophic changes or frank gangrene. At this time occlusive disease of the arteries is recognized, but the type of disturbance frequently is not diagnosed. Raynaud's disease or erythromelalgia may be confused with thrombo-angiitis obliterans, or the latter mistaken for arteriosclerotic disease.

For correct orientation of the usual vascular disturbances of the extremities a classification materially assists in differentiating the main types. (Table 1.) Diseases of the peripheral arteries can be divided into two main types depending on their functional or organic nature: the functional or vasomotor disturbances, and the organic or obliterative disturbances. Each of these can be subdivided according to local or general distribution.

## FUNCTIONAL OR VASOMOTOR DISTURBANCES

The functional or vasomotor diseases of a localized nature are represented by two clinical entities (both of local distribution): (1) Raynaud's disease representing a functional disturbance of a vasospastic nature, and (2) erythromelalgia, a functional disturbance characterized by intermittent vasodilatation.

*Vasospastic disturbances.*—The primary vasospastic disturbances of the peripheral parts include a large heterogeneous collection variously designated as acrocyanosis, acro-asphyxia, "dead finger", and so forth. They

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June, 1927.

are all representative of vasoconstrictive disturbance of the peripheral arterioles, as indicated by the low surface temperature of the affected extremity. The accompanying color changes are due to variations in the surface capillaries and venules. The functional nature of these conditions is shown by the normally pulsating arteries and the prompt recovery in most instances of the color of the skin and the increased skin temperature by exposure to elevated local and environmental temperatures. The non-progressive course of these disturbances in most cases and the complete disappearance of the disturbance in the feet following lumbar ganglionectomy is further confirmation of this. Strictly speaking, Raynaud's disease should not be diagnosed in the absence of a two-phase or three-phase color reaction of the skin and pain or trophic disturbances. Calorimetric studies of the affected limbs and microscopic studies of the surface capillaries indicate that the basic disturbance is similar in all of these forms of vasospastic conditions. In the typical case of Raynaud's disease with the intermittent pallor, cyanosis and at times rubor of the extremities, the arterioles, capillaries and venules of the skin exhibit abnormal contractility to minor

TABLE 1

TENTATIVE CLINICAL CLASSIFICATION OF ARTERIAL VASCULAR DISEASES*

| | | | |
|---|---|---|---|
| Functional or Vasomotor types | Local distribution | Vasoconstricting types | 1. Multiple-phase color reaction: Raynaud's disease. |
| | | | 2. One-phase color reaction; acrocyanosis, dead finger, local syncope. |
| | | Vasodilating types | Erythromelalgia. |
| | General distribution | Vasoconstricting types | Primary or essential hypertension, early stages. |
| | | Vasodilating types | Primary or essential hypotension. |
| Organic types | Local distribution | | 1. Arteriosclerosis, with or without thrombosis; diabetic gangrene. |
| | | | 2. Thrombo-angiitis obliterans. |
| | | | 3. Simple thrombosis or embolism. |
| | | | 4. Arteritis of known infectious origin (rheumatic, syphilitic).† |
| | | | 5. Aneurysm with or without thrombosis. |
| | General distribution | Arteriosclerosis. | |
| | | 1. Primary. | |
| | | 2. Secondary to hypertension. | |

* In our experience, this classification will cover practically all the usual forms of arterial vascular disease.

† Pathologic rather than clinical.

degrees of cold; when contractility is marked in the arterioles, capillaries and venules, the skin is pale. This is followed by cyanosis indicating partial opening of these vessels. Blood slowly enters the capillaries from both the arterioles and veins. The capillary loops gradually dilate and lose their typical shape. The flow is greatly retarded or static, and oxygen unsaturation of the capillary blood occurs to a degree to produce visible cyanosis (Fig. 1). Full restoration of flow brings oxygenated blood to the capillaries, more vessels open and the red or over-recovery stage is present. Bizarre and incomplete clinical types are observed, representing intermediate degrees of constriction and dilatation of the surface vessels, many of which have no clinical significance. The essential points in diagnosis of the functional cases are (1) the open palpable arteries and the presence of pulsations; (2) the intermittent color and temperature changes with complete or over-recovery usually following exposure to increased local and environmental heat, and (3) the distribution which frequently occurs in all four extremities.

The secondary vasospastic disturbances occurring as a symptom of organic vascular disease show color changes of a single or double phase in the hands or feet (pallor or cyanosis). The symmetrical or bilateral disturbance observed in the primary vasospastic disturbances is less constant. The palpable arteries show absent or diminished pulsations in one or more vessels of the hands or feet and as a rule give a clue to the underlying organic nature of the disease. Vasomotor disturbances occurred in thirty per cent. of our cases of thrombo-angiitis obliterans or Buerger's disease, and in about ten per cent. of the cases of peripheral arteriosclerotic disease. A familiar example of the latter group is the "dead-finger" phenomenon observed in older subjects with arteriosclerosis.

*Vasodilator disturbances.*—These conditions are less clearly defined than the spastic disorders. Weir Mitchell described a clinical entity, erythromelalgia, characterized by attacks of redness, increased heat and burning pain of the feet, and at times of the hands. The arteries, capillaries and veins were dilated during the attacks. No organic basis was determined in his cases. The functional nature of the condition is evidenced by its intermittent character, non-progressive course and the relief afforded by cold and change of position. Gangrene or trophic disturbances do not occur, since the supply of blood is not decreased. The underlying upset in this primary vasodilatation disease is an intermittent vasodilatation of the peripheral arteries, capillaries and venules. Increased surface heat is demonstrable during attacks and is due primarily to dilatation of the arterioles; the dilatation of the capillaries and venules produces the redness. Many additional capillaries are opened. The surface temperatures and rates of heat elimination of the feet during attacks show large increases in the volume flow of blood. The attacks are brought on by exercise, hot weather, and occasionally by excessive bed covering. Relief is obtained by cold applications, elevation of the part and lowered environmental temperature. To one patient coming under our observation, life was made

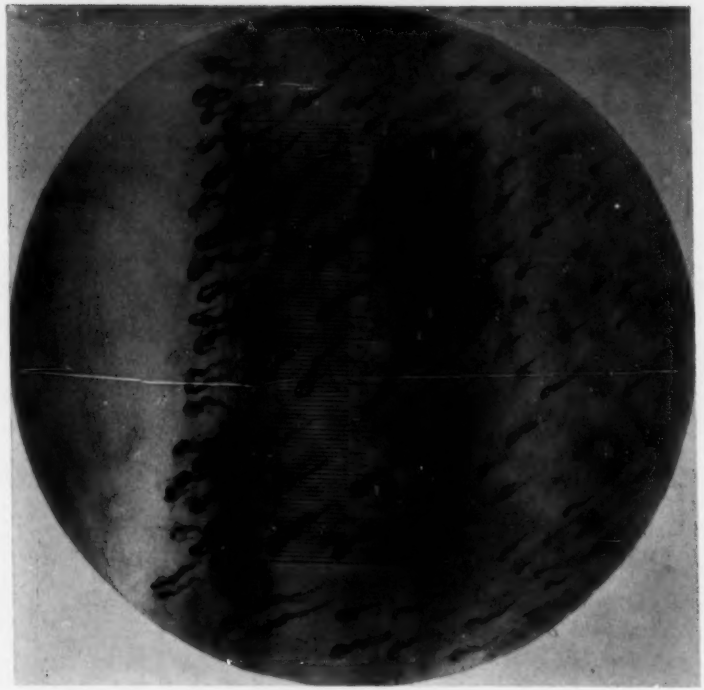

FIG. 1

Nail-fold capillaries in a case of thrombo-angiitis obliterans, with vasospastic disturbances simulating Raynaud's disease. Hand below heart level. Note the dilated capillaries, especially in the venous limb, and the broken segmented appearance of the loops. Many capillaries are open. There is not the excessive dilatation of the loops as observed in Raynaud's disease.

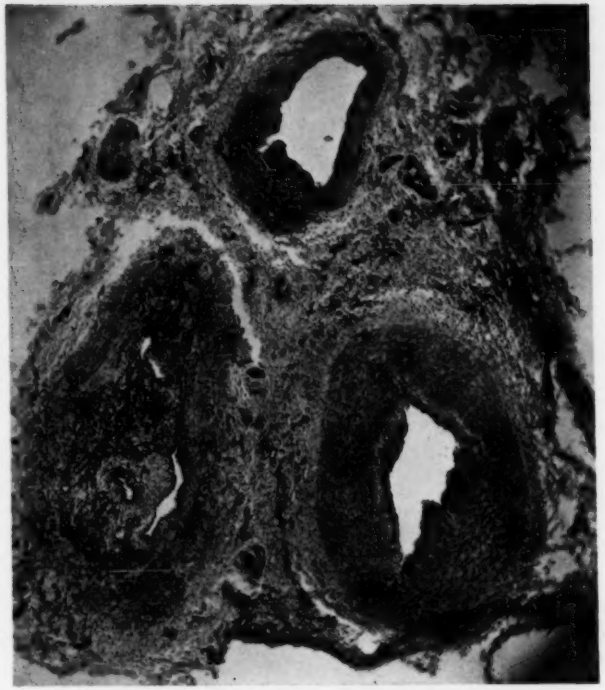

FIG. 2

Healed lesion in thrombo-angiitis obliterans. Note the perivascular fibrosis binding artery and veins together. Canalization of arterial thrombus. Many new formed vessels in the perivascular tissue.

tolerable during the summer months by living on the banks of the Mississippi river and walking barefoot on the wet, cool sand. Increased flow of blood is not the sole factor in producing the symptoms, as many normal subjects will have equally high surface temperature without disagreeable subjective sensations. A heightened individual sensitivity is an additional factor.

There are many intermediate or abortive types of allied conditions with vasodilatation that lack clinical nomenclature, such as the intermittent burning of the feet without redness.

A secondary form of erythromelalgia with redness and burning of the feet is observed in subjects in the arteriosclerotic age. The complaints are similar to those with the primary or essential type of disturbance, but increased blood flow and elevation of the surface heat is only slight or negligible. Burning is complained of while the skin temperature of the feet is not increased. This is largely paraesthesia and seems to be due to irritation of the temperature nerves of the skin. It is usually present in subjects with atrophic or senile changes in the skin.

### ORGANIC OR OBLITERATIVE DISEASES

*Thrombo-angiitis obliterans.*—There are two main types of organic or occlusive lesions affecting the arteries of the extremities: thrombo-angiitis obliterans, or Buerger's disease, and arteriosclerotic disease with or without thrombosis. Diabetic gangrene is a form of the latter disease. These types include more than ninety-five per cent. of the organic arterial diseases of the extremities.

Von Winiwarter described the first case of thrombo-angiitis obliterans in 1879 and noted a proliferation of the intima with an inflammatory reaction of the walls of the vessels. Buerger (1908) reported a large group in the Jewish race and to him we owe the description of the pathologic changes, and the sequence of development, and the clinical description of this interesting disease. He emphasized the inflammatory nature of the lesion, the presence of giant cells and the cellular nature of thrombosis in the acute lesions of the arteries and veins. In the chronic or reparative stages of the disease organization and canalization occur in the thrombus, and the inflammatory exudate is replaced by periarterial fibrosis, binding artery and vein in a dense adherent mass (Fig. 2). The main vessels of the extremities are also involved. Extension of the lesion into the smaller vessels and at times into the smallest capillaries may occur. The disease is frequently relapsing, one segment of the vessel becoming thrombosed, organized and canalized, followed by a repetition of the same process in another portion of the vessel. The pathologic sequence of the disease may be followed by studying the lesion in the superficial veins. Superficial phlebitis occurs in about thirty per cent. of the cases (Fig. 3). Involvement of the deep veins is shown by varying grades of oedema, provided postural causes for the oedema can be eliminated. We have studied more than 170 cases of this disease during the last four years.

FIG. 3

Superficial phlebitis in thrombo-angiitis obliterans. Trophic changes in the nails and marked rubor of the toes with the foot in the pendant position.

There is no known specific cause for this disease. The course and pathologic changes certainly suggest an infectious basis. Rabinowitz has isolated an organism from patients with which he produced vascular lesions in rabbits. This work has not been substantiated. There are several possible contributing etiologic factors, including tobacco, race, age, sex, and exposure to cold.

Tobacco has been assigned as a major exciting cause by Meyer. Jones analyzed the tobacco history in this group and found a much higher incidence of subjects using excessive amounts of tobacco as compared to a control series of males of similar ages. In a small group of cases tobacco was never used in any form.

Thrombo-angiitis obliterans has been described as a disease of the Russian Jews. In our series slightly more than fifty per cent. were Jews. This incidence exceeds by many times the percentage incidence of registration in the Clinic for this race. The racial incidence will depend largely on the section of the country, higher in Jews in the urban districts and higher in Gentiles in the rural districts. The disease is not uncommon in China, Japan, Korea, and Turkey; one questionable case has been found in a Negro by Gemmill. We have not had a proved case in the female sex, but Meleny and Miller reported a case in a Chinese woman that was highly suggestive of thrombo-angiitis obliterans.

The variations in the course and types of the disease are many. Twelve main clinical types have been observed: (1) the slowly progressive, (2) the non-progressive, (3) the early compensated, (4) the acute fulminating, (5) gangrene without pain, (6) venous involvement only, (7) pulsating pedal arteries, (8) vasomotor phenomena simulating Raynaud's disease, (9) associated arteriosclerosis, (10) without symptoms, (11) sudden vascular occlusion and (12) severe rest pain without trophic changes.

Claudication is an important symptom in this disease. In fifty-one per cent. of our cases this was the first symptom. Recognition of the significance of claudication is most important, and gives the clue to the vascular basis of the complaint in an unmistakable manner. This symptom appears early in the feet and is described as the arch or heel type of claudication. It has two significant characteristics, pain and cramp produced

by exercise, and relieved by rest. It is an expression of anoxemia and indicates deficient supply of blood for the muscles under conditions of work. Claudication is usually unequivocal and unfortunately in many cases the significance is not appreciated. The longest history of claudication was fifteen years and the shortest, two months. Abnormal fatigue (a form of claudication) without pain or cramps was the first symptom in eleven per cent. This symptom is again an expression of impaired supply of blood and is clear-cut evidence of the vascular nature of the underlying disease. Coldness of the extremities was the first symptom in twelve per cent. of the cases. Color changes in the feet are usually next in sequence. This sign is most striking, and marked rubor or reddish cyanosis appears with the feet in the pendant position and pallor when elevated. Next in order of development may be trophic disturbances; acute thrombosis with cyanosis of single toes, development of ulcers following trimming of nails or meddlesome surgery imposed on the toes.

FIG. 4

Thrombo-angiitis obliterans involving the hands. Radial and ulnar arteries are occluded. Auto-amputation occurred in the tip of the finger, followed by healing.

With the onset of trophic changes or gangrene a second type of pain occurs, the so called rest pain in contradistinction to the claudication or exercise pain. The rest pain is usually excessive, continuous and severe. Sleep is fitful or impossible. The physical and mental status is affected. The relief of pain constitutes the outstanding problem of this stage, the success of which determines in many cases the eventual preservation of the limb.

The disease is usually bilateral, although there is a difference in the time of the involvement. In thirty per cent. of the cases the upper limbs are also affected, although symptoms are usually mild or absent (Fig. 4). Involvement of the abdominal vessels was noted in one case. Two of our patients, both young men, presented signs and symptoms of coronary thrombosis; one recovered, the other died.

*Obliterative lesions due to arteriosclerosis.*—The second type of organic vascular disease of a localized nature is that of arteriosclerosis with or without thrombosis. Such cases are usually well understood and correctly diagnosed, since gangrene and old age are so frequently held synonymous.

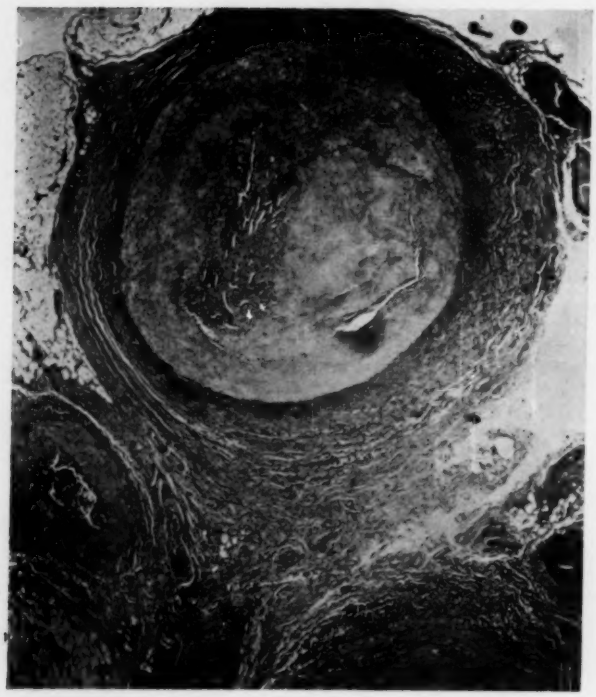

FIG. 5

Arteriosclerotic disease with thrombosis of artery. Note the acellular nature of the thrombus and absence of perivascular fibrosis.

The lesion in this type of case is arteriosclerosis of the peripheral arteries. In the early or presymptomatic stage, the intima shows proliferation of irregular distribution. There is fibrosis and atrophy with deposits of calcium in the media, the so called Mönckerberg's sclerosis. Thrombosis is usually the factor producing complete vascular occlusion (Fig. 5). The pathologic picture of arteriosclerosis, and thrombo-angiitis obliterans is entirely different, and differentiation is easy, except in the occasional case in which both conditions are present. In the arteriosclerotic lesion with thrombosis, the clot is acellular, and inflammatory reaction is absent in the thrombus and wall of the vessel. Giant cells, purulent foci and periarterial binding are absent. The thrombosis is of the so called bland or non-reacting type.

The clinical course of the arteriosclerotic disease is milder than in Buerger's disease. The period of diminishing blood supply is manifested by claudication, in feet or calves. Increasing coldness of the feet and mild color changes follow. When gangrene develops, the rest type of pain is less severe and the progress is usually slower and more benign than observed in thrombo-angiitis obliterans.

## TREATMENT

The treatment of the various vascular diseases has been highly individualized and is necessarily different for the two main types. In the vasomotor types, with color and low surface temperature indicating vasoconstriction, treatment is not indicated in the absence of pain or trophic changes. Prophylactic measures are advised for protection of the extremities in the colder months of the year and frequently climatic changes

are necessary. In many instances reassurance is the sole requirement in the mild painless cases. With frank Raynaud's disease of the hands, no known curative treatment is available, while in the lower extremities lumbar sympathetic ganglionectomy is curative. The treatment of erythromelalgia and allied vasodilator syndromes is most unsatisfactory. Radium has been used over the areas of burning with questionable results. Roentgen rays were applied over the lumbar and sacral spine in one of our cases with some improvement. Frequently the treatment resolves itself to symptomatic relief of the attacks of burning by immersion of the feet in cold water. Partial control of the symptoms is obtained by elevation of the lower limbs at night, and atophan.

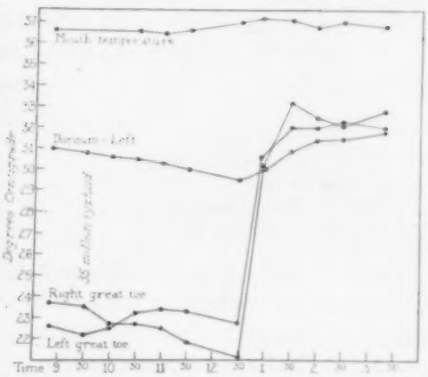


FIG. 6

Thrombo-angiitis obliterans. The response of the body temperature and surface temperature of the feet to intravenous injection of foreign protein. Increase of the skin temperature of the toe of 10° C, with an increase of systemic temperature of 1.5° C. This response explains the beneficial effects of non-specific protein therapy and also forms a basis for the selection of cases for lumbar ganglionectomy.

The cases of organic occlusive disease of the arteries present entirely different therapeutic consideration. The treatment in the early or pre-gangrene stage is protective and active; such as strict admonition against surgical "tinkering", extreme care in the handling of the feet, proper shoes, and avoidance of all forms of traumatic and thermic insults. Active treatment is directed toward increasing the blood supply in the collateral circulation. Postural exercises, contrast baths for the extremities, graduated exposures of the parts to electric-light baths and restriction of activity are most important measures, and are conducive of great good if persisted in over long periods.

With gangrene and continuous pain, the chief problem is the relief of pain. The usual narcotics are useless. Injection of foreign proteins will give relief for variable periods in eighty per cent. of the cases (Fig. 6). If pain can be controlled, measures can be carried out to heal the trophic ulcers. If pain cannot be controlled, surgical measures, namely amputation, and destruction or interference in the vasoconstrictor paths are advised.

Amputations above the knee in cases of organic closure of the main vessels due to thrombo-angiitis obliterans has been the usual surgical procedure. The recent study of Allen and Meyerding indicates the need for revision of this concept (Table 2). Their results show that amputation below the knee is successful in eighty per cent. of cases provided pre-operative and postoperative measures of treatment are carried out. Similar results cannot be obtained in cases of gangrene due to arteriosclerotic disease. Lumbar ganglionectomy has been performed by Adson in eleven

TABLE 2

SURGERY OF THE EXTREMITIES IN THROMBO-ANGIITIS OBLITERANS

| OPERATION | NUMBER OF CASES | | SUCCESSFUL | |
|---|---|---|---|---|
| | Mayo Clinic | Elsewhere | Mayo Clinic | Elsewhere |
| Incision of toes or removal of toe nails | 0 | 15 | .... | 1 |
| Amputation of toes | 6 | 25 | 4 | 7 |
| Amputation below the knee | 12 | 9 | 10 | 7 |
| Amputation above the knee | 7 | 9 | 6 | 9 |

cases of thrombo-angiitis obliterans. In nine the results were satisfactory. Relief from pain was complete, and large trophic ulcers healed. The application of this operation rests entirely on the careful selection of the case; one must show that vasodilatation can occur in the collateral vessels before operation. In selected cases, gratifying results are observed. The exact status of the operation in this disease will be determined only after long periods of postoperative observation.

## DIFFERENTIAL DIAGNOSIS AND DISCUSSION (TABLE 3)

We believe that in no field of medicine does more confusion exist than in localized vascular disturbances. The reasons for this are manifold: the failure to make a sharp distinction between the functional or organic, underlying or primary disturbance, the occurrence of vasomotor phenomena in the organic vascular disease; and thrombosis in the distal arteries of the extremity in the presence of open pulsating arteries in the usual palpable areas. The separation of the vasomotor or functional disturbances from the organic obliterative disease of the vessels is possible in more than

TABLE 3

DIFFERENTIAL DIAGNOSIS OF VASCULAR DISEASE AFFECTING THE EXTREMITIES

| | Thrombo-angiitis obliterans | Arteriosclerotic disease | Raynaud's disease and similar conditions | Primary erythromelalgia |
|---|---|---|---|---|
| Pulsation of arteries | Pulseless 50 per cent. Diminished 45 per cent. Normal 5 per cent. | Pulseless 50 per cent. Diminished 45 per cent. Normal 5 per cent. | Normal | Normal |
| Excessive rubor with dependency | Present | Present | Absent | Absent |
| Excessive pallor with elevation | Present | Present | Absent | Absent |
| Claudication | Usually present | Usually present | Absent | Absent |
| Gangrene | Common | Common | Rare | Never |
| Rest pain | Usually very severe | Usually mild | Usually absent | Usually mild |
| Type of rest pain | Sharp, stinging | Aching | Absent | Burning |
| Appearance of gangrenous ulcers | Moist, inflamed; discharging | Usually dry | Small punched-out areas | None |
| Superficial phlebitis | 30 per cent. of cases | Absent | Absent | Absent |
| Age | Mostly between twenty-five and forty-five years | Mostly between fifty-five and eighty-five years | Mostly between seventeen and thirty-five years | Mostly between thirty and fifty years |
| Sex | Males 99 per cent. | Males 90 per cent. | Females 95 per cent. | Females 70 per cent. |
| Race | Hebrews 50 per cent. | Any | Any | Any |
| Roentgenogram of arteries | Usually negative for sclerosis | Usually positive for sclerosis | Negative | Negative |
| Color changes following exposure to cold | 30 per cent. | 15 to 20 per cent. | Always | Never |
| Temperature of extremities | Low | Low | Low | High |
| Oedema | Frequent | Infrequent | Absent | Absent |

ninety per cent. of the cases by determining the presence or absence of pulsations in the peripheral vessels and by careful analysis of symptoms and physical manifestations. In five per cent. of cases of thrombo-angiitis obliterans, thrombosis occurs in the pedal vessels, while in the proximal arteries pulsations are normal or diminished. As a further aid in deciding the functional and organic nature of the disease the circulatory efficiency test, as described by Buerger, is valuable. In principle this consists in noting the color changes of the extremity following elevation to 180 degrees. In the presence of obstruction of the arteries a varying degree of pallor appears within a few minutes. When occlusion of the vessels is confined to the toes, pallor is limited to these areas. With the feet in the dependent position, the color gradually returns, the extent of the collateral circulation is shown by the irregular advancing color, and the foot after a variable time becomes intensely red or cyanotic. This is the so called reactionary rubor. This simple test to determine vascular obliteration yields data of greater value, in our opinion, than is obtained with more complicated methods, such as the determination of the rates of heat loss, surface temperature, and salt-absorption tests. In our experience palpation of the peripheral vessels, the analysis of symptoms and the performance of the circulatory efficiency test will permit a sharp separation of the functional and organic disturbances in ninety-five per cent. of the cases of peripheral vascular disturbances. When the obstructive lesion is confined to the toes, marked cyanosis usually follows and the diagnosis of Raynaud's disease is erroneously made. The circulatory efficiency test will frequently reveal marked grades of pallor and the retarded return of color in the affected digits. We have amputated single toes in twelve subjects with digital thrombosis with pulsating proximal vessels. The microscopic examination of the vessels showed the characteristic obliterative lesion of thrombo-angiitis obliterans. Intermittent color changes in the extremity are a striking phenomenon and unduly impress both the physician and the patient; they are erroneously taken as evidence of Raynaud's disease or erythromelalgia. Vasomotor disturbances in the male should not be diagnosed Raynaud's disease or erythromelalgia without careful consideration of an underlying organic disease. In our experience ninety per cent. of adult men under fifty years with a history of color changes in the hands and feet subsequently proved to have thrombo-angiitis obliterans. Frequently the vasomotor phenomenon is present in one foot with pulsating dorsalis pedis and posterior tibial arteries, while the vessels in the opposite foot or the radial or ulnar artery show that pulsations are absent, thus giving a clue to the organic nature of the disease. Marked redness in the hands and feet in thrombo-angiitis obliterans is often erroneously diagnosed as erythromelalgia. This error is inexcusable, as the parts are cold, the red color is constant in the dependent position and vessel occlusion is evident. Erythromelalgia is a rare disease, especially the true or primary form. Color changes are not the *sine qua non* for diagnosis, but intermittent attacks of burning and local heat are the underlying or basic disturbance. The effects of exercise and increased

environmental temperature and posture on the initiation of attacks are quite constant.

The separation of the two main forms of vasomotor disturbances is usually simple if one recognizes that vasoconstrictor disturbances cause cold extremities and vasodilator disturbances cause warm or hot extremities. The color changes represent capillary reactions and are not the fundamental disturbances. Both types of vasomotor disturbances are intermittent, and temporary recovery can be induced by changing the environmental or local temperatures. This recovery response is absent or less marked in the vasomotor disturbance occurring in the occlusive arterial disease.

There are many borderline vasomotor disturbances of the hands and feet that lack nomenclature. The intermittent "dead finger", the cold red hands most common in adolescent girls, and the paroxysmal cyanotic digits, are examples. Clarity is not preserved by attempting to provide nomenclature for all these functional states as they represent variations of the same type of a constrictive vasomotor disorder. Müller has classified or grouped them as examples of a "vasomotor constitution". Many of these conditions are of no clinical importance and merely represent an overacting or hypersensitive peripheral vasomotor mechanism occurring in individuals of a definite constitutional type. Many cases of true Raynaud's disease do not progress to gangrene or severe trophic disturbances.

The separation of the two main types of organic or obliterative disease is usually not difficult. The age of the patient makes this decision possible in the majority of instances. There is a group of male subjects between the ages of forty-five and fifty-five in whom separation is most difficult. Since thrombo-angiitis obliterans is of doubtful occurrence in the female, this difficulty does not present itself in this sex. The duration of the symptoms frequently indicates that the patient was in the pre-arteriosclerotic age at the onset of the disease. Roentgenologic evidence of calcified arteries will frequently throw light on the nature of the obliterative lesion. The finding of calcified arteries by the roentgenogram may lead to error, as medial calcification *per se* does not implicate vessel occlusion, and degeneration of the vessel wall will not produce symptoms. This observation must be correlated with symptomatic evidence of arterial insufficiency, as claudication, abnormal local fatigue and local coldness. In arteriosclerotic disease of the extremities there is usually collateral evidence of degenerative changes in the retinal or radial vessels, and of senility or senile changes in other tissues. Night cramps and rest pains in the absence of trophic changes are not primarily vascular in origin. The history or presence of superficial phlebitis is of great value, as this condition, in our experience, is almost never found in the arteriosclerotic disease. Occlusion of arteries in the upper extremities, either with or without symptoms, is corroborative evidence of thrombo-angiitis obliterans. The correct diagnosis of these

cases is of more than academic interest. Early recognition of the organic nature of the disease will allow the institution of prophylactic measures before the onset of gangrene. The correct diagnosis of arterial insufficiency will prevent meddlesome surgical procedures on the nails and toes. In fifty per cent. of our cases gangrene was initiated by surgical trauma. Elimination of foci, including teeth and tonsils, and especial attention to the prostate has been carried out systematically in our cases on empirical rather than proved grounds. Correct advice regarding trauma, care of callosities, and nails and the effects of cold will prevent gangrene in many cases. The extreme seriousness of this disease, affecting as it does the young, active, adult male and involving both lower extremities, with resultant amputation in a large percentage of cases, throws a heavy responsibility on the physician who sees these cases in the early stages. The orthopaedist frequently assumes this responsibility. An error in diagnosis at this stage of the disease usually spells disaster for the unfortunate patient. Experience is teaching us that correct early diagnosis, intelligent advice, and physical and medical measures to increase circulation will permit vascular compensation to be established in many of these cases. The former pessimistic attitude held toward this disease is not justified. Conservative treatment carried out for long periods will prevent a large percentage of amputations. The excellent conservative results obtained in our cases with lower level of amputations, is due largely to the close cooperation of the orthopaedic and medical services. The patient is treated and studied carefully and if amputation is necessary the medical treatment is continued postoperatively. The results have amply justified the additional expenditure of time.

## SUMMARY

Extreme confusion exists in the correct differentiation of the different vascular disturbances of the extremities. This is due largely to failure to make the fundamental distinction between the functional or vasomotor, and the organic or obliterative lesions. Careful investigation of all the palpable arteries is the *sine qua non* of the differential diagnosis. This allows the primary differentiation in more than ninety per cent. of the cases. The circulatory efficiency test is also of great value in making the decision as to the functional or occlusive nature of the disorder. Many cases of thrombo-angiitis obliterans and arteriosclerotic disease present vasospastic disturbances with color changes in the hands and feet; this leads to erroneous diagnosis. Early recognition of thrombo-angiitis obliterans is of great importance, as gangrene is frequently prevented. Meddlesome surgery of the toes was the irritating factor in producing gangrene in fifty per cent. of our cases. Minor surgical measures on the feet of elderly persons, particularly men, must not be undertaken without the condition of the arteries first having been determined. Cognizance of this fact will prevent gangrene in a definite percentage of cases of arteriosclerotic disease.

## BIBLIOGRAPHY

1. Buerger, Leo: Thrombo-angiitis Obliterans: A Study of the Vascular Lesions Leading to Presenile Spontaneous Gangrene. Am. J. Med. Sc., CXXXVI, 567, 1908.
2. Gemmill, W. F.: Thrombo-angiitis Obliterans. Atlantic Med. J., XXIX, 244, 1926.
3. Meleney, F. L., and Miller, G. G.: A Contribution to the Study of Thrombo-angiitis Obliterans. Ann. Surg., LXXXI, 976, 1925.
4. Meyer, Willy: A Further Contribution to the Etiology of the Thrombo-angiitis Obliterans. Med. Rec., XCVII, 425, 1920.

   The Etiology of Thrombo-angiitis Obliterans. Med. Rec., XCV, 901, 1919.
5. Rabinowitz, H. M.: Experiments on the Infectious Origin of Thrombo-angiitis Obliterans and the Isolation of a Specific Organism from the Blood Stream. Surg. Gynec. and Obstet., XXXVII, 353, 1923.
6. Winiwarter, F. v.: Ueber eine eigenthümliche Form von Endarteriitis und Endophlebitis mit Gangrän des Fusses. Arch. f. klin. Chir., XXIII, 202, 1879.

## DISCUSSION

Dr. Walter G. Stern, Cleveland, Ohio: The writers have succinctly called attention to the importance of circulatory disturbances as a cause of pain, disability and disease; the symptoms of these nutritional disturbances ranging from the mildest burning or paraesthesias to the severest imaginable pain and gangrene.

In my own experience the functional types of the disease predominate and in our own northern, central states climate, we always find a flock of such patients coming in at the first appearance of frost.

The division of circulatory disturbances into two types, vasodilator and vasoconstrictor, should not be overlooked, as their treatment is to be sharply differentiated.

I miss from their analytical table, the "traumatic" cases so ably described by Cramer (Archiv. für Orthopädie, Mechanotherapie und Unfallchirurgie VII, 341, 1909) under the formidable title of "Uber metatraumatische vasomotorisch-trophische Neurosen". These traumatic cases, in my experience, are rather common and often result from rather mild traumata and may be the cause of an otherwise unexplainable osteoporosis. It is in the treatment of these monotraumatic cases that we have found periarterial sympathectomy to be of any benefit.

The authors have not overemphasized the great importance of the early recognition of the organic or obliterative types, in which immediate steps must be taken to reorganize the patient's existence so that he may be able to live in comfort and freedom from pain and the danger of disintegration of the afflicted parts.

Buerger is altogether too pessimistic in his outlook as to the prognosis. If, after reading his book, one is converted to his views, then there really seems to be nothing else to do except to amputate in the severer cases. We have had several patients with typical thrombo-angiitis, with all the classical circulatory disturbances, wandering phlebitis, etc., in whom excised arteries and veins showed the typical thrombotic changes characteristic of the disease, but who have remained free from all attacks of the disease for many years.

We also have never been able to grow any cultures from these fresh specimens, although properly using all the approved media.

There is one point I wish to add, and that is to urge the use of all the modern mechanical, physical and physiological tests for circulatory sufficiency in arriving at a diagnosis, and in a complete study of a case. I refer to the use of the oscillometer, viscosimeter, capillary microscope, calorimeter, pyrometer, salt injection (wheel) test, etc., etc.

The injection of radiopaque substances directly into the arteries for radiographic study, modern mechanical, physical and physiological, is believed by us to be a very dangerous procedure and is not to be recommended. The hypodermic needle pyrometer

is an accurate measure of circulatory sufficiency—as is the calorimeter; but the first has many mechanical disadvantages and is not without its dangers; the second is a pure laboratory test and not applicable to routine hospital or office examination (Stewart). The value of the capillary microscope has already been dwelt on in the paper.

The viscosimeter differentiates the various types of disease from the thrombo-angiitis (Buerger's disease) type in which I have practically always found a high blood viscosity, and which is held by some observers to be a disease of the blood itself on this account. The oscillometer measures the amplitude of the arterial beat and is useful in a confirmatory way. The salt injection wheel test as advocated by Cohen and myself at the Dallas meeting of the American Medical Association is, we believe, quite an accurate measure of circulatory sufficiency and is easily and quickly performed.

By the use of the above enumerated methods, a case can be pretty accurately studied and the effects of treatment noted. They are good guides as to the necessity of and the level of operative interference.

It is quite gratifying to hear of the success the authors have had in relieving the symptoms of some of their severer cases with lumbar sympathetic rhizotomy. I am convinced that the method of attempting to influence the sympathetic system by means of x-ray exposures is of little or no value, while Lerich's method of periarterial sympathectomy has only influenced the traumatic cases.

# CONGENITAL DISLOCATION OF THE KNEE JOINT

## Case Report

BY ARTHUR S. GRISWOLD, M.D., BRIDGEPORT, CONN.

In view of the rarity of the above congenital lesion and the complete recovery from an otherwise severe deformity which followed immediate reduction and immobilization, the following case is reported.

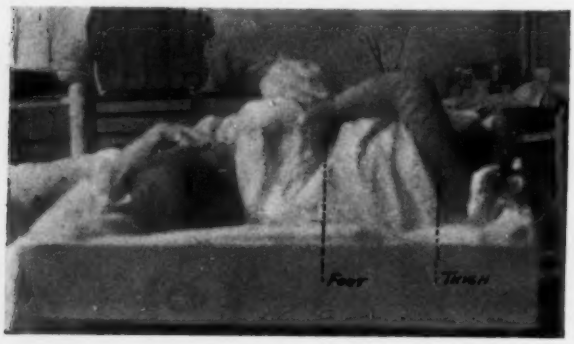

Fig. 1
Showing child before treatment.

Baby M., a white female infant, was delivered spontaneously by vertex presentation in August 1926. Examination in consultation the same day, when referred to the orthopaedic service of Dr. George W. Hawley, revealed a baby normal in every respect except for the right leg. There was here present an anterior dislocation of the knee with hyperextension of so marked a degree that the toes could be placed in contact with the upper abdomen. The skin in front of the knee was slack and markedly wrinkled, and no patella was palpable. In the popliteal space the condyles of the femur, especially the external, could be felt projecting, the tibia being displaced forward and rotated inward on the femur. On the same side was present a talipes calcaneovalgus of moderate degree, the opposite foot being quite normal.

By manipulation it was found that the dislocation could be reduced with little difficulty, but not more than twenty degrees of flexion could be obtained, apparently due to shortening of the quadriceps. On testing the stability of the reduction by releasing the foot, a certain amount of hyperextension immediately developed, following which the tibia could be seen to rotate inward; at a certain point the condyles slipped suddenly back into the popliteal space and the leg jerked up into approximation with the thigh as the dislocation became complete.

Reduction, when secured by a second manipulation, was maintained by adhesive strapping from thigh to foot in twenty degrees of flexion, the maximum obtainable at the time without the use of force. Careful attention prevented irritation from the adhesive, which was changed daily, each time more knee flexion being secured until by the fourth day flexion was complete. This position was maintained, the adhesive being changed at frequent intervals, until the tenth day when all dressings were removed. Contraction of the structures behind the knee had already progressed to such a degree that the leg now extended spontaneously ten degrees short of full extension. No sign of recurrence was evident when patient and mother were discharged two days later.

Examination on October 30, 1926, when the child was two and one-half months old, showed no tendency whatever to hyperextension. When last seen, in April 1927, the two knees could not be distinguished one from the other.

A similar case of congenital dislocation of the knee has been reported recently (*Journal of Bone and Joint Surgery*, VIII, 822, October 1926) by C. H. Baldwin who obtained an excellent result. Treatment in his case was delayed until the tenth day when anaesthesia was found necessary and full function was obtained only after four weeks. It would seem that immediate treatment may achieve as good a result and avoid the necessity of a general anaesthetic.

# OSTEOCHONDRITIS OF THE SPINE

## With Report of Two Cases

BY SAMUEL W. BOORSTEIN, M.D., F.A.C.S., NEW YORK

Recently there have appeared several articles in the orthopaedic literature describing osteochondritis of the spine. Calvé[1] wrote a paper entitled "A Localized Affection of the Spine Suggesting Osteochondritis of the Vertebral Body, with the Clinical Aspect of Pott's Disease". He cited two cases. Buchman[2] referred to the work of Calvé, reviewed the work on allied conditions, and added two cases of his own.

FIG. 1

Case 1. Theodore G. Feb. 4, 1927. Note the wedge-shaped D-7. The intervertebral discs are clear.

A case similar to the one described by Calvé came under the author's observation in February 1927. As these cases are probably more numerous than we have hitherto believed, it may be of value to report them in detail so that a clear understanding of this entity may be established and it may be differentiated from similar conditions.

CASE 1. Theodore G., a boy, aged seventeen. Referred to the author on February 4, 1927, by Dr. C. J. O'Connor for deformity of the spine.

*History:*—For the last six months father has noticed that when the boy stoops forward to pick up things the spine is deformed; or, as he expressed it, "one hip is higher than the other". No pain complained of by the patient.

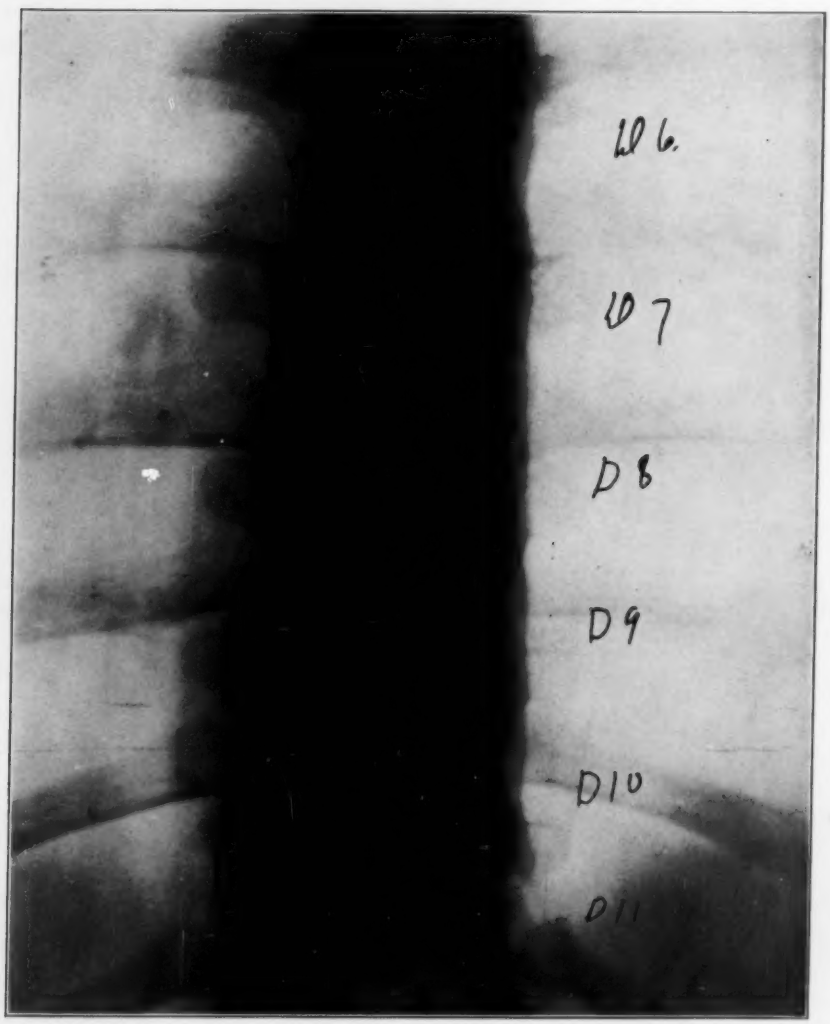


FIG. 2

Case 1. Theodore G. Feb. 4, 1927. Anteroposterior view showing good structure of D-7 and no involvement of contiguous bones.

*Physical examination:*—Patient is very tall. Walks without a limp. When undressed, the spine shows a slight curvature with the convexity to the left dorsal. Marked lordosis present. When patient bends forward there is a marked gibbus at the region of seventh dorsal. No spasm in the spinal motion. No pain on jarring. No tenderness over the gibbus. When patient sits, the scoliosis disappears but the gibbus remains. Both feet are markedly everted, left more than right. No spasm of the feet present. Measurements of the lower limbs show no shortening.

In considering a proper diagnosis, one could see that it was not a real scoliosis as it disappeared when patient was sitting. The other diagnosis was Pott's disease. This was of course entertained on account of the gibbus; but there was no spasm of the spine. Boy looked in good health and never complained of pain.

A radiograph then taken showed a distinct wedge-shaped seventh dorsal, also a slight erosion of the contiguous parts of the sixth and eighth dorsals. The structure of the

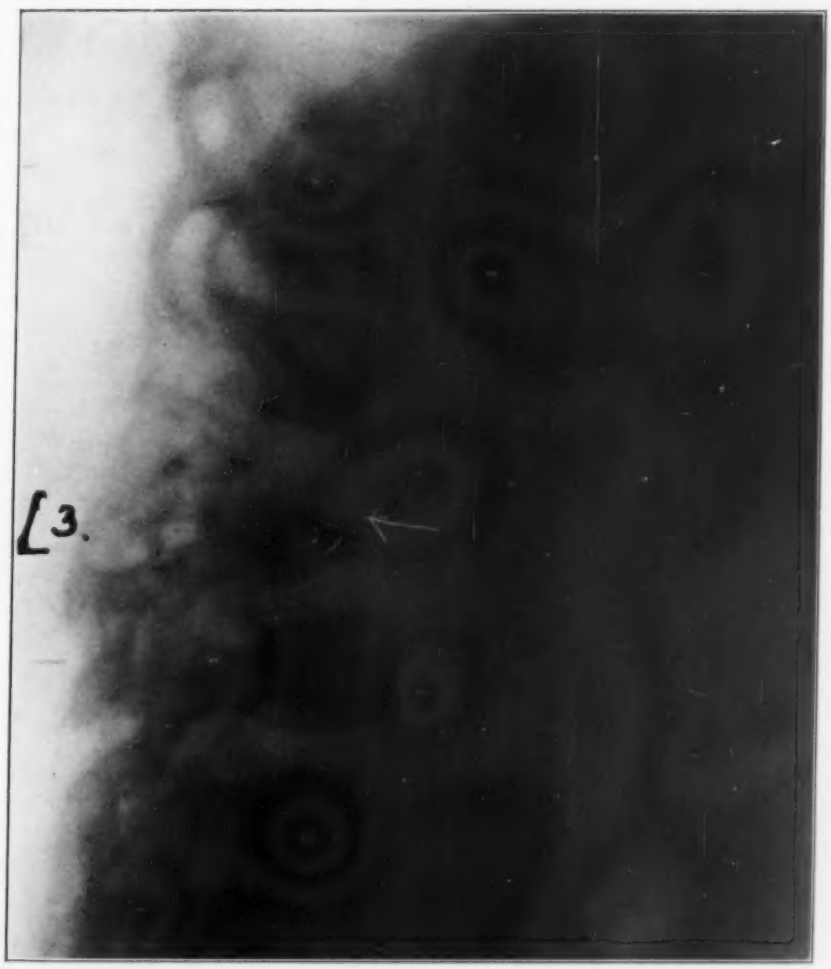


FIG. 3

Case 2. Muriel L. Feb. 20, 1925. Note wedge-shape of L-3 and absence of involvement of intervertebral discs.

body of the dorsal vertebrae was good. The intervertebral discs were clear and there was no evidence of perivertebral involvement (Figs. 1 and 2). A Wassermann was taken and reported negative.

In answer to inquiry for an injury to exclude fracture of the spine, patient reported none. Two weeks later he recollected that some time in the summer he had fallen out of a hammock, landing on his back but suffered no pain, either then or subsequently.

*Comment.* The patient had absolutely no pain and came only for the slight scoliosis. The spine showed no spasm. Motion was free in all directions, but on extreme flexion the "knuckle" increased. The history of trauma is very unreliable in this case. He recollected the fall out of a hammock only after two weeks. Had there been a real injury, a young man of his size would have complained and no doubt would have been confined to bed. The radiogram shows distinctly the diminution of the anterior part

FIG. 4

Case 2. Muriel L. June 19, 1925. Note that the intervertebral discs are still free, also absence of involvement of contiguous bones.

and a roughened edge of the adjacent vertebrae above and below and intact condition of the adjacent discs. When one looks at the worm-eaten appearance of the seventh dorsal, he immediately recollects the fragments of bone of the coxa plana. The intervertebral discs are so clear that one can positively exclude Pott's disease or an old fracture. The case must therefore be placed in the category of the developmental diseases: coxa plana, tibial epiphysitis, etc.

As far as the cause of the affliction in this patient is concerned, none could be found with the exception, perhaps, of the slight injury. A plaster cast was applied, left on for six weeks and then a brace applied. The lordosis has diminished immensely and the general condition of the patient has improved.

After studying this case the writer recollected that a few years before he had had a patient in whom clinical symptoms did not point towards tuberculosis; still the radiograms showed definite involvement of one vertebra. He had that patient under his observation for a very long time, had many radiographs taken, but could not come to a definite diagnosis. On reading Calvé's article and having come across the above cited case, he looked up the previous one which is reported below as Case 2. Though not as typical, it may be placed in this same group.

Case 2. Muriel L., female, aged two when referred to me on November 2, 1923, by Dr. J. Carucci.

*Family history* negative. A few years later mother died from pulmonary tuberculosis.

*Present illness* began two months before, with pain in the back. No pain at night. Mother also noticed that child was awkward in gait and had a slight deformity of the back.

*Examination:*—Child is big for her age. Walks with slight stiffness of the back. Can bend forward to pick up objects from the floor. No pain on jarring. There is a

Fig. 5

Case 2. Muriel L. June 19, 1925. Anteroposterior view. Note the fair structure of the bone.

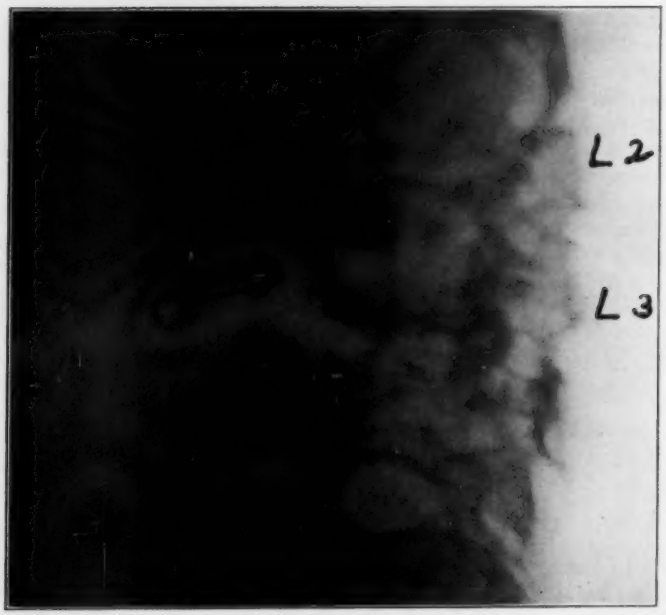


FIG. 6
Case 2. Muriel L. March 10, 1927. Note that L-3 is almost entirely absorbed. No callous formation. Some involvement of L-2. The intervertebral discs are still free.

slight kyphosis at the lumbar region which disappears when child is suspended by the hands. Slight spasm in the spine on hyperextension but not enough to warrant a diagnosis of tuberculosis. Child has evidence of rickets viz., pot belly and boxy wrists but no bow legs or knock knees. Radiogram showed slight rarefaction of the third lumbar but the intervertebral discs were clear.

Diagnosis of Pott's disease was made. Child was treated with a plaster jacket and pressure pads over the gibbus. Notation made at that time reads that the condition is not tubercular and the treatments instituted were rather to prevent further deformity and observe progress.

*Progress:*—Child improved rapidly. The corset was later on changed to a removable one and sun treatments were instituted.

Radiogram on February 20, 1925 (Fig. 3) shows that the condition is progressing. The body of the third lumbar is almost completely destroyed. The second lumbar and fourth lumbar show slight erosion but there is no evidence of a really active spondylitis.

The plaster was later on changed for a brace, and Alpine treatment commenced. Spasm disappeared and deformity markedly diminished. No pain on jarring (Figs. 4 and 5). When last treated, in 1926, she had no pain and no spasm, but a slight deformity.

The author again examined her on March 10, 1927, and found the following: The back is straight but there is a slight prominence of the region of the second and third lumbar vertebrae. It is not a distinct gibbus. Flexion, extension and lateral motion of the spine seem to be limited in the lumbar region but no spasm is present. Hyperextension of the spine by the legs produces no spasm. There is no tenderness over the region of the spine or no psoas abscess. Child walks without a limp, even without the brace.

X-ray shows complete absorption of the third lumbar, with some absorption of the second lumbar, but the intervertebral discs are clear (Figs. 6 and 7).

## CONCLUSIONS

1. Every case of deformity of the spine suggesting osteochondritis should be studied carefully so as to establish a definite symptomatology of this entity.

FIG. 7

Case 2. Muriel L. March 10, 1927. Anteroposterior view. No ankyl[illegible]s as is usually seen in tuberculosis.

2. Vertebral osteochondritis is characterized by deformity of the spine in the form of a knuckle or a generalized kyphosis or scoliosis, but with very slight or entire absence of pain.

3. The roentgenograms usually show only one vertebra affected, which assumes a cuneiform shape. There is absolutely no involvement of the discs above and below the diseased vertebra. The cartilage usually is thicker and there is often new formation of this tissue.

4. The etiology is unknown as in the cases of Legg-Calvé and Osgood-Schlatter's disease.

5. The treatment is immobilization in plaster-of-Paris jacket or a brace. Source of infection should be sought.

*Acknowledgment*—The author wishes to acknowledge his sincere thanks to Dr. I. J. Landsman for the roentgenograms carefully taken by him.

## REFERENCES

1. CALVÉ, J.: A Localized Affection of the Spine Suggesting Osteochondritis of the Vertebral Body, With the Clinical Aspect of Pott's Disease. J. Bone and Joint Surg. VII, 41, 1925.
2. BUCHMAN, J.: Osteochondritis of the Vertebral Body. J. Bone and Joint Surg. IX, 55, Jan. 1927.

# THE FORMATION OF "RICE BODIES" IN TUBERCULOSIS*

BY MARK H. ROGERS, M.D., BOSTON

NOTE: In the July issue of the *Journal* appeared an article by Dr. E. B. Mumford, of Indianapolis, on "The Origin of Rice Bodies in Bursal Sacs". Dr. Mumford's article was received by the *Journal* some weeks before this paper was presented by Dr. Rogers at the Annual Meeting of the Association. It is an interesting coincidence, however, that these cases were being treated by these two men at practically the same time and that from their observations they independently arrived at the same conclusions as to the etiology of "rice bodies" in tubercular lesions.—*Editor.*

The origin of the so called "rice bodies" that are found in certain forms of joint tuberculosis and in tubercular synovial lesions is not described in the text-books of pathology. The author has not been able to find any references to this subject in the literature except that it is stated that they are probably formed from detachments of the synovial membrane or from fibrin. The following case is reported with complete pathological studies because it shows the probable origin of "rice bodies".

Miss G. M., aged twenty-five, presented a swelling of the flexor surface of the forearm just below the wrist, which did not cause any severe symptoms for three years. This was supposed to be a tenosynovitis. Three months before examination there developed a swelling on the outer side of the hand, over the fifth metacarpal. This swelling was tense and slightly fluctuant. The day previous to examination she received a slight injury to the hand and evidently sustained a pathological fracture of the base of the fifth metacarpal. The x-ray shows the fracture and also shows a loss of substance of the outer surface of the metacarpal. This was interpreted as a compression necrosis, due to the constant pressure of the tumor mass.

The tumor over the fifth metacarpal was dissected out. On opening the sac, which could be fairly well freed from normal structures, there was found a large number of "rice bodies", about fifty. On making pressure on the tumor in the wrist, more bodies were delivered into the open wound through a small opening near the attachment of the flexor carpi ulnaris.

Six weeks later the tumor in the wrist was dissected out intact up to the opening toward the palm. It was connected with the tendon sheaths, especially the flexor carpi ulnaris. The mass measured one inch by one-half inch by one-half inch. On opening it, it was found to consist of a thick-walled sac, packed full of "rice bodies", slightly smaller than those in the tumor on the hand.

The microscopic section of the wall of the sac in both hand and wrist showed typical tuberculosis. Some of the "rice bodies" were put into a guinea-pig, and on autopsy the pig showed tuberculosis. Tubercle bacilli were found in the "rice bodies" on proper staining.

On microscopic section of the tumor of the wrist, the "rice bodies" were packed in layers, in regular order, completely filling the sac. All the bodies were lying free except those next the sac wall. These appeared to be in various stages, some just free, and others evidently attached to the wall. In several places were seen "rice bodies" as if they were in the process of "hatching" or being extruded from the wall.

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

FIG. 1

Shows loss of substance of half the shaft of the fifth metatarsal with a spontaneous fracture in the base, so called pressure necrosis.

FIG. 2

Drawing of the tumor in the wrist and bisected in the middle, showing the formation of the layers of rice bodies, some free and some attached.

FIG. 3

Low power microscopic section of tumor showing rice bodies free and partially attached to the capsule.

FIG. 4

High power microscopic section of rice body being extruded from the center of the tubercle.

On microscopic section the "rice body" had a fibrous thin capsule with a homogeneous, even staining center without structure. Near the inner edge of the sac wall is seen a typical tubercle. The center of the tubercle shows the same staining property and the same homogeneous, structureless tissue as seen in the "rice body". One of the tubercles looks as if it possibly could be extruding its centre to form a "rice body".

From a study of this case it is shown that "rice bodies" are composed of tubercular material, that they are at first attached to the wall of a tubercular sac, and that very probably they are formed from the center of a tubercle.

## DISCUSSION

Dr. W. E. Blodgett, Detroit, Mich.: The significance of the careful study of the reported case is that rice bodies always mean tuberculosis and are not part of other disturbances of the synovial tissue.

Dr. William Arthur Clark, Pasadena, Calif.: It seems to me the most significant thing Dr. Rogers brought out is that he found tubercle bacilli in the wrist lesion. Of course we usually do not find tubercle bacilli in tuberculous joints. I only remember one case of my own where the bacilli were found and that was not in a tuberculous joint, it was in the trochanter. The fact that rice bodies are found would lead us to suspect that they are accumulations of synovial tubercular debris. This is rather new to me and when I got Dr. Rogers' paper several days ago I tried to look up some literature on the subject but did not find any. This is the only case that I have seen or heard of.

Dr. John L. Porter, Chicago, Ill.: I should like to ask Dr. Rogers a question,—have you followed the formation of rice bodies from the synovial membrane lining the joint? If so, you should be able to find incomplete rice bodies.

Dr. J. Torrance Rugh, Philadelphia, Pa.: I should like to ask Dr. Rogers what was the result of the removal of this sac of rice bodies.

Dr. Mark H. Rogers, Boston, Mass. (Closing the discussion): In answer to Dr. Porter, I am very sure that that was shown in many places in the specimen.

Answering Dr. Rugh, it is six months since the operation, and both wounds have stayed tight. That does not mean that they will stay.

# MOVABLE BULLETS IN THE SPINAL CANAL

BY LEO P. BELL, M.D., WOODLAND, CALIF.
*From the Department of Surgery, Woodland Clinic*

Trauma to the spinal cord, resulting from a bullet wound, is rare in civil life. Reports of movable bullets in the spinal canal are extremely rare. The immediate mortality and end results depend upon:

1. The location of the injury.
2. The amount of laceration, concussion and bruising of the cord.
3. The extent of intra and extra thecal hemorrhage.
4. The length of time elapsing before laminectomy is done for relief of pressure on the cord whether from hemorrhage, bullet, or depressed bone fragments.
5. The amount of infection introduced by the bullet or by operative intervention.
6. Injury to structures of the body, other than the cord.

Bullet wounds in the cervical region cause a much higher mortality and result in many more complications than do wounds in the lumbar region.

When there is extensive laceration of the cord in the cervical or thoracic region, death occurs in a relatively short time from paralysis and the resulting infections in the urinary system. Those surviving have varying degrees of permanent paralysis from cord injury.

The immediate mortality resulting from injuries of like nature in the lumbar region is much less. Bullets, depressed fragments of bone, and organized blood clots are tolerated for a longer period and the progress of secondary changes is much less rapid than in traumata of the cervical or thoracic region.

As soon as shock has passed, laminectomy should be done to prevent pressure destruction of the cord and to allow relief of tension caused by swelling and oedema.

Infection from the bullet largely depends on the laws of chance; infection from operative intervention, on the technique of the surgeon. Unless skillfully managed, injuries to other organs may result disastrously in cases otherwise suitable for operative relief.

A careful review of the literature reveals no instance of a movable bullet either in the cervical or thoracic region of the spinal canal. The reason is easily seen when we consider the anatomy. The size of the canal in the vertical and transverse diameters of the lumbar region is much greater than it is in either the cervical or thoracic region. In the cervical and thoracic areas the cord almost fills the dural sac and the spinal canal. The lumbar region which encases the major portion of the cauda equina presents the proper condition for mobility of bullets piercing the dural sac. (See Figure 1.)

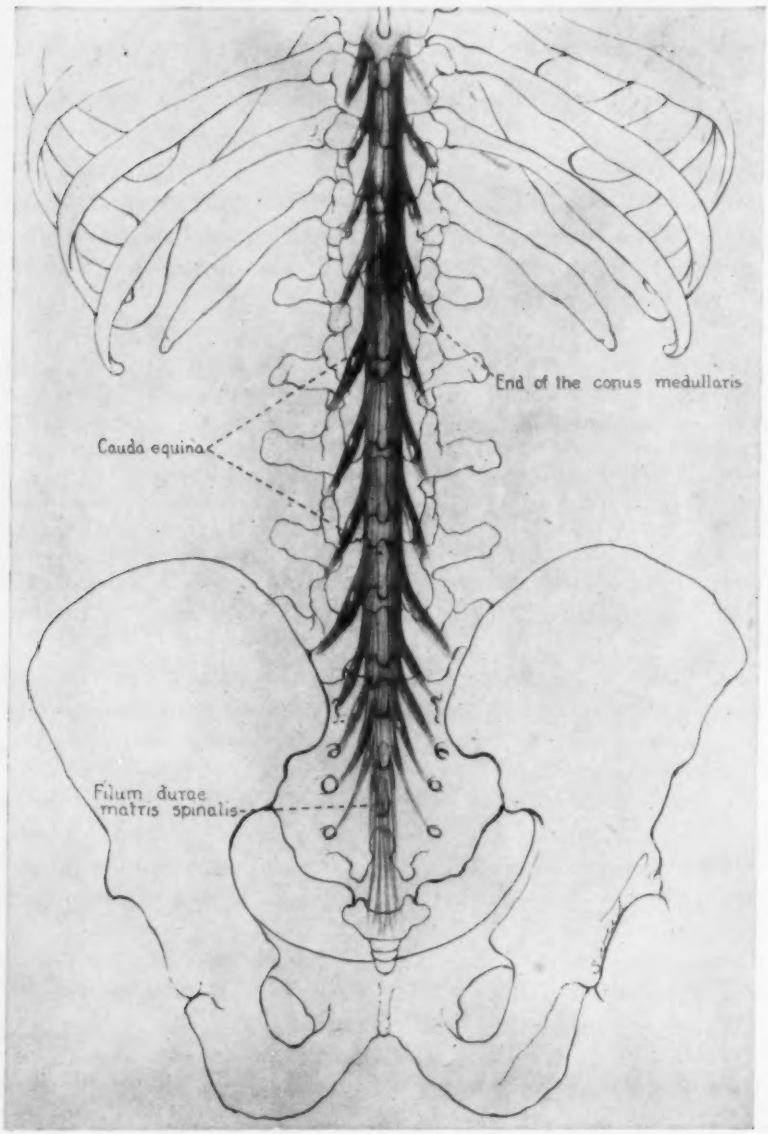


FIG. 1
Schematic drawing of cauda equina of lumbar region.

Symptoms from bullets lodged in the spinal canal in the lumbar region vary with the amount of actual destruction of the filaments of the cauda equina and with the length of time the bullet has been allowed to remain within the canal. If a laminectomy has been done with removal of blood clots and foreign bodies within a few hours after the trauma and if the patient has not recovered or had satisfactory end results, we may conclude that there has been direct trauma and destruction of nerve filaments.

When a bullet is allowed to remain in the canal for a long time, it becomes surrounded by organized blood clots, which may result in pressure disturbance to the filaments of the cauda equina. This disturbance indicating destruction of the nerve filaments may be manifested within a few months or be prolonged over a number of years. The immediate symptoms may be due to disturbance of the rectal or vesicle sphincters. Sensory fibres may be irritated, causing severe pain in the legs, sacrum or buttocks, disturbance to the sensations of heat, cold, etc., or loss of sexual power. There may be zones of hyperaesthesia corresponding to the location of the bullet. Paralysis of the extremities or muscular atrophy will occur according to the nerve fibres affected.

Movable bullets within the dural sheath of the lumbar region have been encountered and removed by Auvray, Bec, Loison and Mignon, Raymond and Rose, Tuffier, and Selberg. In each instance the patient had had a diagnosis made and was operated upon within the first two or three months following the original injury. Two or three laminectomies were done on each patient before removal could be effected, because the bullet had shifted its position and did not present itself in the operative field. Selberg's patient had severe pains in the right popliteal space when sitting up. When recumbent, the pains disappeared, indicating a location of the foreign body not constant as to position.

In their experiences, the postoperative return of the impaired functions of the bladder and rectum was slow, extending over a period of from one to two years. Disappearance of pain and disturbance of sensation was almost immediate.

Bullets which have remained in the lumbar region of the spinal canal for a long period induce the formation of fibrous tissue in their vicinity, with resulting compression of the filaments of the cauda equina. The symptoms vary with the length of time the bullet has remained in the canal and with its position in relation to the cord. The clinical picture is, as a rule, that of slowly increasing pain in the legs, constipation, difficulty in walking and inability to void, with resulting bladder and kidney infection.

Hassin and Johnstone, Braun, Chipault, Hutin, Engelmann, Raymond and Rose, Raymond, and Vickery have encountered bullets firmly lodged within the dural sheaths in the lumbar region, which had been in the canal for from three months to six years. In each instance laminectomy was done with partial or almost complete recovery.

Ollivier, Weisenburg, Lamb, and Leyden report cases which had never been operated upon, in which the bullets were tolerated from three to eighteen years before death occurred.

Collier described an injury at the level of the third and fourth lumbar vertebrae which showed extensive destruction of the cauda equina from intra thecal and extra thecal hemorrhage. The patient was operated upon fourteen days after the injury and died from renal infection three or four months later.

Bellot reports a case in which a laminectomy was done one and a half

FIG. 2
Lateral view with bullet lodged at level of fifth lumbar vertebra.

years after the injury. Death resulted from ascending myelitis and a progression of symptoms caused by a transverse lesion of the cord.

The following case from the Woodland Clinic is reported as an addition to the literature concerning sliding bullets in the spinal canal:

S. A., male, aged seven, entered the hospital February 21, 1926. A No. 32 bullet had passed through the left arm above the elbow, and entered the abdomen.

*Physical Examination:* Patient in marked shock. Bullet wounds above the left elbow and in the upper left quadrant of the abdomen. The anterior portion of the left leg, from hip to knee, was insensitive to pain, pressure and temperature. Extension of the left leg was limited. The pupils of the eyes were dilated.

*X-ray examination* showed a bullet in the spinous process of the first sacral vertebra. (See Figures 2 and 3.)

*Urinalysis* essentially negative except for red blood cells IV and albumin I.

*Operation, February 21, 1926:* Exploratory laparotomy. Perforation of the spleen found and sutured. Transfusion of 400 c.c. of citrated blood given.

*Operation, February 26, 1926:* Exploration of the fifth lumbar and first sacral vertebrae, with laminectomy, failed to reveal the bullet. Immediately after this

FIG. 3

Anteroposterior view with bullet lodged at level of fifth lumbar vertebra.

operation the fluoroscopic examination demonstrated the bullet at the level of the fourth lumbar vertebra. Laminectomy was done on the third lumbar vertebra. The spinal canal was opened at the levels of the third and fifth lumbar vertebrae, which had been previously opened, and probes were passed in, above and below. The bullet was not found. Shots were sewn into the point of exploration and an x-ray examination

FIG. 4

Anteroposterior view with bullet lodged at level of second lumbar vertebra.

made; the bullet was seen at the level of the second lumbar disc. (See Figure 4.) Because of the patient's condition, no further operative work was done at this time.

On March 2, 1926, the x-ray showed the bullet at the upper level of the third lumbar vertebra. (See Figure 5.)

*Operation, March 2, 1926:* Laminectomy of second lumbar; probe passed without finding the bullet; the cord was lifted to one side and the bullet found at the level of the third lumbar, anterior to the cord. (See Figure 6.) Fibrin completely surrounded the bullet. It was removed without difficulty. The child made an uneventful recovery and was dismissed from the hospital on March 28, 1926. When last seen (December 1926), the child had made complete recovery and evidenced no signs of symptoms of neurologic disturbance.

It would seem that all bullets entering the dural sheath in the lumbar region are movable, or potentially so, until they become stationary from

FIG. 5

Anteroposterior view with bullet lodged at level of third lumbar vertebra.

inflammatory reaction and fibrosis. If we accept the very small number of patients who have suffered the accident and who have come to operation as a criterion, we conclude that this inflammatory fixation probably takes place after four or five months.

Auvray has suggested the use of the tripod of Hirtz for localization before attempting operative intervention. He elevated the head and shoulders of his patient so that the bullet would gravitate to the point of the laminectomy.

Since the bullet's change of position probably occurs when the patient is transferred to the operating table or during anaesthesia, the following suggestions are made:

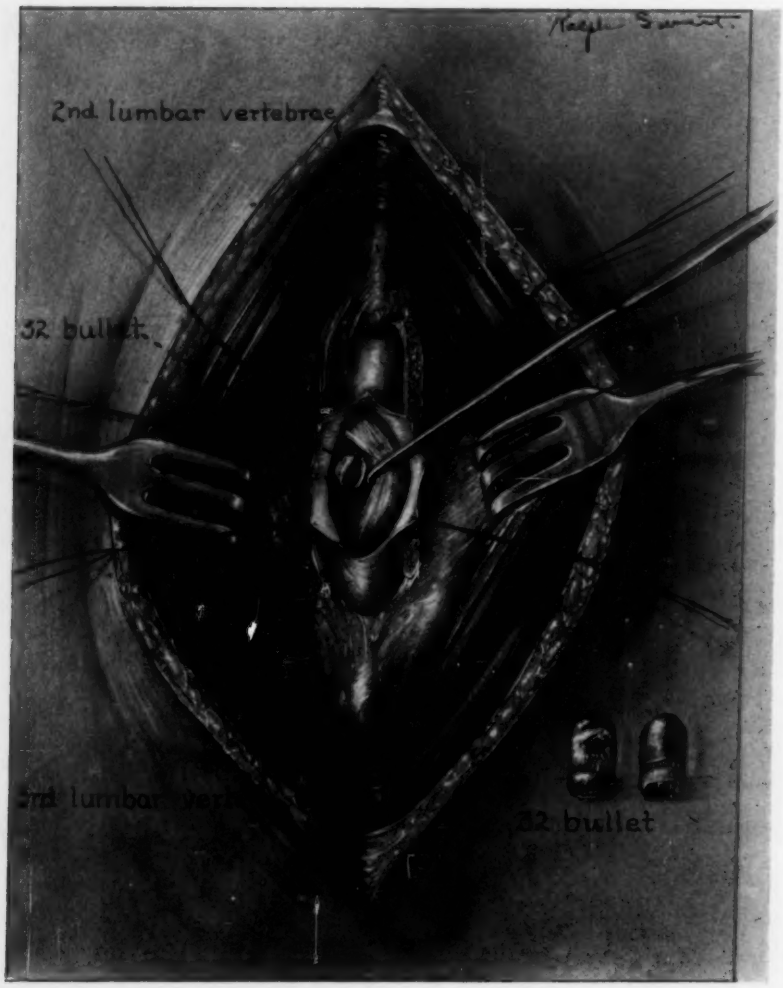


FIG. 6
Position of bullet in relation to cord.

1. Stereoscopic x-ray pictures should be made just before placing the patient on the operating table.

2. There should be the least possible movement of the patient's body after roentgenological localization.

3. Laminectomy should be done under local anaesthesia, insuring stability of the patient's body.

4. The head of the table should not be elevated to allow the bullet to gravitate into the operative field. This might mean an extensive and serious loss of cerebrospinal fluid.

Very few x-ray laboratories are equipped with a tripod of Hirtz. It presents no advantages over the operating room fluoroscope, which is

accurate in localization and accessible. The operation should not be begun without this accessory.

## CONCLUSIONS

1. All bullets lying within the dural sheath in the lumbar region are movable or potentially so.

2. Bullets lodged in the spinal canal should be removed as soon as possible.

3. It is unjust to the patient to undertake the removal of a bullet in the spinal canal without the aid of an operating room fluoroscope.

## BIBLIOGRAPHY


1. Auvray, Maurice: Balle de Shrapnell mobile à l'Intérior du Canal rachidien, extraite au Milieu des Nerfs de la Queue de Cheval. Bull. Acad. de Méd., Paris, LXXVI, 447, 1916.
2. Bec: Gazette Méd. de Paris, LXXXVII, April 12, 1916. Cited by Auvray.
3. Bellot, Victor: Balle de Fusil tolérée pendant dix-sept mois dans la Queue de Cheval, avec Guérison fonctionnelle. Réveil tardif et fatal de l'Infection. Bull. Acad. Méd., Paris, LXXVII, 749, 1917.
4. Braun, W., and Lewandowsky, M.: Beitrag zur Frage der operativen Behandlung der Rückenmarksschüsse. Deutsche Ztschr. f. Chir., XCIV, 115, 1908.
5. Chipault, A.: Maladies du Rachis et de la Moelle. Extrait du Traité de Chirurgie. Paris, J. B. Baillière et Fils, IV, 881, 1897.
6. Collier, James: Gunshot Wounds and Injuries of the Spinal Cord. The Lancet, I, 711, 1916.
7. Engelmann, Fritz: Akute Kompression des Cauda equina durch ein Projektil, Operation, Heilung. München med. Wchnschr., LI, 2292, 1904.
8. Hassin, G. B., Johnstone, K. L., and Carr, A. M.: Bullet lesion of Cauda Equina. J. Am. Med. Assn., LXVI, 1001, 1916.
9. Hutin: J. de méd. et de chir. prat., XX, 512, 1849. Cited by Hassin, Johnstone, and Carr.
10. Lamb, E.: Cited by Vincent.
11. Loison and Mignon (1901). Cited by Auvray.
12. Leyden, E.: Traité clinique des Maladies de la Moelle Epinière. Translated by E. Richards and C. Viry. Paris, J. B. Baillière et Fils, 262, 1879.
13. Ollivier, C. P.: Traité des maladies de la moelle Epinière. Ed. 3, Paris, Mequignon-Marvis, I, 358, 1837.
14. Raymond, F. and Rose, F.: Compression des racines de la Queue de Cheval par Balle de Revolver, Laminectomie, Guérison, Rev. neurol., XIV, 381, 1906.
15. Raymond, F.: Sur quelques Affections de la Queue de Cheval. Arch gén. de Méd., II, 1940, 1906.
16. Selberg, Ferdinand: Shrapnellkugel in der Cauda Equina. Wandern der Kugel im Duralsack. Zentralbl. f. Chir., Leipzig, XLIV, 162, 1917.
17. Tuffier and Aubourg (1909). Cited by Auvray.
18. Vickery, D. H.: A Bullet in the Cauda Equina. Brit. Med. J., I, 302, 1921.
19. Vincent, E.: Des Plaies par Coup de Feu de la Moelle Epinière. Rev. de chir., XII, 89, 1892.
20. Weisenburg, T. H.: A Clinical Report of Three Cases of Injury to the Lower Spinal Cord and Cauda Equina. Am. J. Med. Sc., CXXVII, 768, 1904.

# A SIMPLE METHOD OF EXCLUDING THE SKIN DURING OPERATION

BY PHILIP LEWIN, M.D., CHICAGO

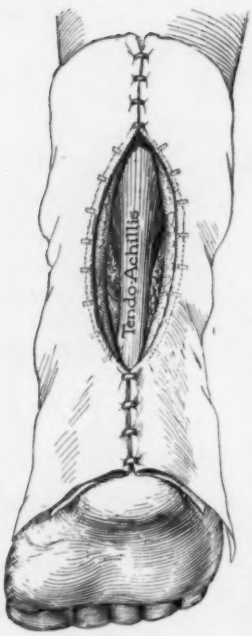


FIG. 1
Application of Michel clips to skin edges and towels.

The accompanying illustration demonstrates a very simple method of excluding the skin edges as a source of infection during operations. When the skin is incised a thin coat of three and one-half per cent. tincture of iodin, or two per cent. mercurochrome, is applied to the edges. A towel is placed over the wound in the usual manner and while an assistant grasps the towel and one skin edge with two toothed forceps, Michel clips are applied as in closing a wound and the towel is folded back. The other skin edge is treated similarly. Clips are then placed in the corners of the wound and on the edges of the towels at both ends. When the operation is complete the clips are removed by grasping both sides of each towel successively and pulling, which forces all clips to come off one side at one time.

The advantages of this method are that it is simple, quick in application, and effective. The clips are not bulky and in the operator's way as are the cumbersome towel clips of the Doyen, Backhaus (June bug) or other types. The clips do not traumatize the skin as do these other instruments. The facility of removal is of importance.

In multiple operations, such as multiple tendon lengthening or operations on the cartilages of the knee joint, this method is very effective. The application is quick, the removal quicker. Since this method was demonstrated to the writer in Liverpool, in June 1925, by Mr. Armour, it has been used extensively.

# COMPARATIVE RESULTS OF OPERATIVE AND NON-OPERATIVE METHODS OF TREATMENT OF TUBERCULOSIS OF THE SPINE IN CHILDREN*

BY F. C. KIDNER, M.D., AND FELIPE MURO, M.D., DETROIT
*From the Clinic of the Children's Hospital of Michigan*

The observations in this paper have absolutely no bearing on the treatment of Pott's disease in adults, but are confined to children under twelve years.

The announcement about 1911 by Albee of the success of the bone transplant in the treatment of early spinal tuberculosis in children, everywhere aroused great interest. Up to that time we had been using, at the Children's Free Hospital in Detroit (now the Children's Hospital of Michigan), the standard methods of treatment,—recumbency, jackets, and braces, with the usual disappointing results. We therefore seized upon the new operation with eagerness, and during the next three or four years did a considerable number of tibial transplant operations. We obtained end results worse than those obtained by the older methods of external splinting because we neglected after-treatment. Our disappointment was coincident with that of many other orthopaedic surgeons.

When the Hibbs fusion operation appeared, we turned to it with hope, but with enthusiasm dampened by the experience with the Albee procedure. By the spring of 1917 a considerable number of children had been operated upon by this method. Warned by the unfortunate experience with the bone transplants, we insisted on prolonged rest and support following the operations. On our return from the army in 1919, we hunted up these cases, and again there was disappointment. The results, although not so bad as those in the earlier transplant cases, were far from satisfactory.

In sorrow we ceased to operate on Pott's disease of the spine in children except in selected cases, and established a rule to which we have adhered ever since, that all Pott's disease must be treated on Bradford frames, under favorable surroundings and kept in absolute recumbency until bony union of the diseased vertebrae is clearly demonstrated by the x-ray.

We feel justified in presenting this short resumé of our experience, because it so clearly reflects the confusion and disagreement seen in the literature of the treatment of Pott's disease. Bradford long ago advocated and practiced prolonged recumbency on his frame. Since his writings we have been urged to try a long series of methods, each of which apparently produced satisfactory results in the hands of its proponent. These methods are divided into those requiring recumbency, and those allowing locomotion with internal and external splinting. In all methods rapid bony

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

fusion of the diseased vertebrae is the goal. Lange placed metal bars in contact with the laminae of the vertebrae. Calot advised forcible corrective jackets of plaster-of-Paris. Calvé told us that operation was of no value in the treatment of children. Ely told us that all cases should be operated on by the fusion method. The conservative Bostonians refused to commit themselves. The more enthusiastic New Yorkers operated.

In the face of all these complexities and disagreements, it occurred to us in 1921 that the matter under discussion might be put to a comparative test, which would have the elements of conclusiveness. The facilities for such a test were provided by the Children's Hospital in Detroit, and its splendid Convalescent Home and School at Farmington, the gift of Senator James Couzens. These two institutions are so closely interlocked by unity of management, staff and finances, and so near to each other (eighteen miles) that children can be completely controlled. There is no limit to the time a child may stay at Farmington, and the efficient ambulance service allows frequent inspection or treatment at the hospital. Dr. Muro resides at the Farmington Home, but comes daily to the hospital. This combination provides an ideal setting for a prolonged comparative test of the operative and non-operative methods of treatment.

In 1922 and 1923 we deliberately chose from the clinic a series of fourteen children all under ten years of age. Most of them were in the early stages of spinal tuberculosis. In all cases the disease was in the dorsal or lumbar regions. These fourteen cases were sent to Farmington as they appeared, and placed on frames under, as nearly as possible, ideal conditions of food, sunlight, and medical care. So far as we were able, we divided them into pairs as regards age, stage of the disease, and general physical condition. From each pair we selected one for operation and one for prolonged frame treatment. The operations were all of the Hibbs type of fusion. The operations were all done at the Children's Hospital and the patients returned promptly to Farmington where they were put back on frames, under conditions similar to the unoperated control child. No child was operated upon until he was in first class general condition. All children were kept under absolutely similar conditions, and all were subject to the same tests of physical and x-ray examination. From time to time children who were clinically free from symptoms, whether operated upon or not, were allowed to get up wearing back braces, in order to test clinically the solidity of the healing. Such tests always led to a recurrence of symptoms in a shorter or longer period, whether the patient was operated upon or not, unless one goal had been reached. This goal was the appearance in the x-ray of a continuous firm bony bridge uniting the diseased vertebrae, and the disappearance of all signs of rarefaction between them. So far as our present experience goes this x-ray appearance means permanent cure. This experience covers only periods of from six to eighteen months without recurrence of symptoms and without any form of support.

A summary of the results in the fourteen children is as follows:

Thirteen of the fourteen are well physically and active.

Eleven have kyphos so small as to be unimportant.

No case has developed abscess, except one which had an abscess when first seen.

One case which was operated upon, has a bad kyphos and is not cured. One has a moderate kyphos.

For the first of these failures there are two reasons: First, the operation did not include enough vertebrae above the disease, and second, the child was taken home against advice, and all treatment withdrawn. When returned to us at the end of a year the damage was done.

For the second a failure in technique prevented complete bony fusion of the laminae and a second operation was necessary.

All the other children, except these two, have flexible useful spines, but we feel that the flexibility is greater in the unoperated cases.

Our conclusions from this set of cases are:

That the cure of tuberculosis of the spine in children between the cervical region and the sacrum depends principally on long continued rest without weight-bearing.

That cases in which fusion has been done require practically as long and careful after-treatment as those without operation.

That unoperated cases when cured have more flexible spines than operated ones.

That the possible shortening of convalescence does not justify the very real risk incident to operation.

All the cases will be kept under observation in the future and a final report made, after a lapse of time. Any or all of them may recur.

A synopsis of the individual cases follows:

### OPERATED CASES

Case 1—R. S. First seen in August 1922, at four years of age, with marked destruction of the second and third lumbar vertebrae, and small abscess. Had slight involvement of left upper lung. Kept on frame at the Convalescent Home until October 1923, when a Hibbs fusion operation was done. In January 1925, following one or two unsuccessful attempts to get him up, he was finally allowed to walk with a back brace. In August 1925, he was sent home. Immediately he returned with pain and spasm. He was put back on frame and, in January 1926, secondary operation was done and two areas of incomplete fusion found. These were repaired, and in April 1927 the patient had been up and about without symptoms for seven months. This case represents one in which too great dependence was put on an operation, which was technically imperfect. The duration of treatment until apparent complete cure was nearly five years.

Case 2—G. M. First seen in September 1922 with a history extending over nine months, of pain in the back. Examination showed disease of the eleventh and twelfth dorsal vertebrae, with very slight kyphos. He was placed on a frame at the Convalescent Home, and kept there until December 1924, at which time Hibbs' fusion operation was performed. This was delayed so long because of poor condition and intercurrent diseases, such as scarlet fever.

In August 1925 he was sent home with a jacket, and in January 1926 was in good condition. In April 1927, having been lost for a year, he returned with acute symptoms,

due first, to insufficiently high operation, and second, to the fact that at no time had real bony union been apparent in the x-rays.

This case represents another failure due to technical errors in operation, and to inability to control the patient. In this case, treatment is still continued at the end of five years.

Case 3—J. P. First seen in July 1923. The x-ray showed active disease of the third and fourth lumbar vertebrae. He was kept in bed at the Convalescent Home for one year because of poor general condition, and in December 1924, Hibbs' operation was performed. In July 1926 he was given a back brace, and sent home.

In December there was no recurrence, and the brace was removed. In April 1927, he was in perfect condition with complete bony fusion of the diseased vertebrae.

His treatment covered a period of three years.

Case 4—E. P. The patient was first seen in December 1923, having had pain in the back for two months. X-rays showed no disease, but a diagnosis of tuberculosis of the lumbar spine was made from the pain and spasm. He was placed on a frame at the Convalescent Home, and kept there until November 14, 1924, a period of eleven months, when a Hibbs fusion operation was done.

During the next eighteen months he was gradually allowed to get up with occasional remissions of the disease. The last one was in May 1926. In September 1926 was finally allowed up and since that time he has been well.

The x-rays show complete bony fusion without symptoms. His treatment covered a period of three years.

Case 5—C. R. First seen in January 1923. He had had a slight kyphos with pain for six months. He was placed on a frame, and sent to the Convalescent Home, where, in March, he developed lobar pneumonia with empyema. His chest was opened in April. This was repeated in June, and in March 1924 the chest had healed. In November a Hibbs operation was done. During the treatment on the frame his kyphos had improved, and in April 1925, he was allowed up with a jacket, and in

Fig. 1

Case 1. R.S. End result showing complete bony fusion obtained with operation.

Fig. 2

Case 1. R. S. This picture shows range of motion, and also shows stiffness of the back, which goes with the operation as mentioned in the text.

June with a brace. In August 1925 he was sent home. In March 1926, the x-rays showed solid bony union, and in April 1927, he was perfectly well with a useful spine.

This patient's treatment covered a period of three years and three months.

CASE 6—L. S. First seen in February 1923, two years of age. Active disease involving eighth, ninth, tenth and eleventh dorsal vertebrae with large kyphosis. On frame at Convalescent Home until November 1925, when Hibbs' fusion operation was done. In this case operation was done with the idea of reenforcing a marked kyphos. Six months after the operation the child was gotten up in a plaster jacket. In September 1926, was sent home with brace. In April 1927, he was in good general condition without symptoms, and without supports.

This case was already far advanced when first seen. Frame treatment overcame all acute symptoms, and somewhat decreased kyphos.

The operation apparently was a success in reenforcing the natural process of healing.

This patient's treatment covered a period of three and one-half years.

CASE 7—F. M. First seen in November 1923, when found to have disease of the third to sixth dorsal vertebrae.

He was sent to the Convalescent Home and there kept on frame until June 1925, when the Hibbs fusion was done. He was allowed up in October, and has since been perfectly well without support, although he has a marked kyphos. This case is unfair to the operation, as the operation was done so late in the course of the disease. His treatment covered a period of four years.

## NON-OPERATED CASES

CASE 1—W. W. First seen April 4, 1923, at seven years of age. There was an active process in his third and fourth lumbar vertebrae, with some kyphos, and marked destruction. There were also irritative cord symptoms. He was put on frame at the Convalescent Home. His irritative symptoms continued for about eight months. He was kept on the frame until October 1924, when a jacket was applied and he was allowed up. There were no recurrences of symptoms. He was given a brace.

He has now been up and about without support for a year and a half, without any symptoms, and with firm bony union. The active treatment of this case covered two years and a half.

CASE 2—B. R. First seen at seven months in February 1921. He was then treated for rickets. In April 1922 he again appeared. The mother said she had just noticed a small lump on the child's back. X-ray showed destruction of the body of the tenth dorsal vertebra, with some involvement of the right lung. He was put on a Bradford frame at the Convalescent Home.

During the next six months he had scarlet fever, otitis media and broncho-pneumonia. By December 1923, his general condition was excellent, but destruction had gone on and the tenth and eleventh dorsal vertebrae were involved. The kyphosis however had disappeared.

In January 1926, he began to walk with a light brace. Since that time he has had no symptoms, is wearing no support, and his kyphos is not visible. There is bony union at the site of his disease. This child's treatment, because of various intercurrent diseases, required four years.

CASE 3—J. N. Two years of age when first seen in November 1923. His x-rays at that time showed destruction of the twelfth dorsal, and first lumbar. He was placed on a frame at the Convalescent Home. The kyphos was considerable during 1924. The kyphos gradually decreased, and the condition of the spine steadily improved.

He has been up and about without support since April 1926, and there is apparent complete bony union, with very small kyphos. His treatment required two and one-half years.

CASE 4—J. W. First seen in May 1924, at four years of age, with pain and spasm,

but no kyphosis, and very slight x-ray appearances of damage to the body of the first lumbar vertebra. He was placed on frame at the Convalescent Home. By the end of 1925 there were no symptoms, and the child was allowed up gradually.

Since that time he has been symptomless, and is now apparently entirely healed.

Duration of active treatment, eighteen months. Complete healing of process according to x-ray.

CASE 5—B. M. First seen in December 1924, at the age of two years. Six weeks before, the family had noticed a slight kyphos in the upper lumbar region. X-ray showed destruction of the third lumbar, and involvement of the second. During 1925, the kyphos improved, and the child was put in plaster.

Since September 1926, the child has been walking freely without return of symptoms, and x-ray shows complete bony fusion. Duration of active treatment two years.

CASE 6—E. O. Two years of age when first seen in March 1924. X-ray showed destruction of the first and second lumbar vertebrae. Treated in the Convalescent Home on frame. By the end of 1925, symptoms had disappeared. There is apparently complete healing of the process, and there have been no recurrences.

Duration of active treatment, one year and two months.

CASE 7—E. L. First seen at five years of age, in October 1923. He had had trouble with his spine for two years, and there was marked kyphosis.

X-ray showed destruction of the eleventh and twelfth dorsal, and first lumbar vertebrae. Placed on frame at the Convalescent Home.

During 1924 the kyphos decreased considerably, and all symptoms disappeared. A small abscess began to show calcification during this period. By 1926 he was allowed up in a jacket, which was renewed in September 1926 because of the amount of the kyphos, and destruction.

The child is still wearing a protective celluloid jacket when active, and the x-rays are not conclusive of complete healing, but there have been no symptoms.

Duration of treatment four years.

FIG. 3

Case 6. E. O. End result showing complete bony fusion obtained without operative interference.

FIG. 4

Case 6. E. O. This picture shows range of motion and flexible spine obtained in cured case without operation.

## DISCUSSION

Dr. John L. Porter, Chicago, Ill.: When the Central States Orthopaedic Club met in Detroit, Dr. Kidner showed us these cases and the demonstration which he made then was, I am sure, very much more valuable and more conclusive to those who saw it than any demonstration that can be made with x-ray and moving pictures. It seems to me that the comparisons of the two different methods of treatment have been well conceived and well carried out. I feel sure that you were all impressed with the fact that the results which he showed us and the clinical results are much more valuable as a means of judgment than any graphic results by moving pictures can be. The end results which he showed were so conclusive, that it is evident that just as good results are to be obtained with the conservative treatment and heliotherapy as with bone transplants or with the Hibbs operation.

From my own experience I have very little to offer. When the suggestion was first made that we fix our tuberculous spines by the Albee method, I operated upon a number of cases,—a series of about ten. As time went on I did not see enough evidence that they got well any faster than those who were not operated upon. I just blamed my technique. I made up my mind that I could not get my cases as well as Albee and Hibbs had done. I have never tried the Hibbs method of fixation, though I believe it would be just as effective as a transplant from the tibia. I was brought up and educated in the school that preceded the discovery of bone transplants, and we had become accustomed to seeing so many good results in tuberculous spines from long continued rest and immobilization that I undertook fixation by transplantation of bone rather skeptically. I must say, after following out those ten or twelve cases operated on five or six years ago, that I have not see enough difference and enough improvement in the operative method over the conservative, fixation method to warrant my continuing it. I am treating all my cases of tuberculosis in children with the conservative method. I am not speaking of adults. In children the time element is not so important because we have schools where they can be educated. I am confining my treatment to rest, immobilization, and heliotherapy.

Dr. Samuel Kleinberg, New York, N. Y.: I have no statistics to offer as I did not know I was going to discuss the paper. I agree with Dr. Kidner as to rest and immobilization being the keynote of the treatment of Pott's disease. For a period of five years I was in charge of the Neponsit Beach Hospital where we had about one hundred children with bone and joint tuberculosis. When I review the results of conservative treatment I agree with Dr. Kidner that conservative treatment is a desirable form of treatment, and I think in the past the majority of cases were successfully treated. But what are we going to do with the children who have been under conservative treatment for three, four and five years, and continue to have pain, disability and perhaps increasing deformity, and persistence of sinuses? It seems to me that there we are driven to use some adjuvant. In these cases the Albee fixation or the Hibbs fixation is, I think, an excellent means of increasing the degree of bone fixation. We know that when in the course of the conservative method we find a patient cured, there is a fixation of the diseased vertebral bodies to the adjoining ones. On the other hand, when one operates one is able to obtain not only fixation of the vertebral bodies, but obtains also bony fusion of the posterior parts of the vertebrae. It seems to me that the union of the posterior arches is an important step in the cure. I am not so much interested in the mobility of the spine as in the results. We are dealing with a serious disease and if the patient gets well without any pain or stiffness and is able to carry on, it is not so important whether he has one hundred per cent. mobility of the spine, or perhaps only sixty-five per cent. In some instances in older children of ten or twelve, where there is increasing deformity, we have done an operation. Spinal fusion is just one step in the treatment, immobilization and rest are the most important elements in obtaining a cure.

Dr. F. C. Kidner, Detroit, Mich. (Closing the discussion): In answer to Dr. Kleinberg's remarks about the intractable cases which have gone on year after year without

improvement, in my experience they only occur when the fixation treatment with hyperextension has not been properly carried out. I fully agree with him that a child of ten or twelve years who still has flare-ups must have a fixation of the spine by the Hibbs method. In such late cases the bone is strong enough to hold as it does in the adult cases. Personally, I believe very strongly in operation in the older cases. In the younger cases the bone does not hold as well as it does in the adult. These conclusions are very much the same as those the Commission of the American Orthopaedic Association arrived at away back in 1920; but there has been so much discussion in the journals in the last few years that I felt it was worth while to carry out this work, which has covered a period of five years.

# STUDIES WITH A QUANTITATIVE TUBERCULIN REACTION

## I. A Quantitative Tuberculin Reaction as an Aid in Bone and Joint Diagnosis*†

BY RODNEY F. ATSATT, M.D., SANTA BARBARA, CALIF.

The study which is being reported below is an attempt to increase the delicacy and thereby the value of the well known intradermal tuberculin test which Mantoux described in 1908[1]. The author wishes to acknowledge the kindly suggestions of Dr. Hans Zinsser and Dr. Allen K. Krause in the preparation and interpretation of the problem.

The tuberculin test, of which there are several types, is a specific phenomenon, depending for its reaction upon the strength of the allergic state of the individual. According to the mode of introduction and amount of tuberculin, the reaction will manifest itself by local, focal, or constitutional signs. The Moro or percutaneous, the Von Pirquet or cutaneous, and the Mantoux or intracutaneous methods produce only local or skin reactions. The Koch or subcutaneous method produces a focal reaction, and if this be severe, a concomitant general reaction. Our interest centers on the intracutaneous mode of administration as the one best suited for quantitative examination.

The phenomenon of allergy upon which these tests are based is a complicated problem in immunity and in order to use the tuberculin test intelligently, one must understand something of the underlying principles involved. Krause, in a long series of studies[2-9], has analyzed the production of allergy during the course of a tuberculous infection and presents a very rational explanation of the tuberculin test.

Krause distinguishes two types of tissue response to the entrance of the tubercle bacillus into the body. The first is the essential or native reaction, and the second is that which occurs with superinfection or reinfection. When tubercle bacilli are for the first time introduced into an uninfected individual, a specific pathological response takes place, gradually walling off the organisms by a slow growth of the fixed tissue or so called "epithelioid" cells. Inflammation is not seen and few if any leucocytes are involved in the process. There is no accompanying toxaemia. This is the native or essential response of the animal to primary infection and, to repeat, is characterized by extreme sluggishness of pathological changes, lack of inflammatory phenomena, predominance of proliferative changes with subsequent formation of tubercle, and total absence of intoxication.

*From the Orthopaedic Service, Massachusetts General Hospital and Children's Hospital, Boston.

†Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 13, 1927.

Quite different from this slow initial response is the reaction of the body to a superinfection or reinfection, no matter whether it be an external reinfection or, as is often the case, a metastatic inoculation from the original focus. In this secondary process there is an immediate true inflammatory reaction accompanied by an outpouring of leucocytes. There is marked activity of the tissues in the areas where the bacilli have lodged, consisting of rapid proliferative and early degenerative or healing changes. There is always intoxication with systemic response, the severity depending upon the extent and virulence of the reinfection.

This altered reaction capacity of the tissues when confronted with a reinfection and found only in individuals in whom anatomic tubercle has been established, is definitive of allergy, and in this paper the term allergy will be used only in this narrow sense,—the changed reaction capacity of the tissues in the presence of primary infection. This allergic or hypersusceptible state of the tissues is an unmistakable indication of the presence of tubercle. Whether this tubercle is active, recently healed, or obsolete, is a question of major importance and will be discussed later.

Analyses of this phenomenon of allergy by Krause[10-11], Zinsser[12-13] and others have postulated the following laws regarding its existence.

1. Allergy is never observed unless anatomic tubercle is present.
2. It appears almost coincidently with the establishment of the lesion and is present in all tissues of the body.
3. It waxes in intensity, to a certain point, as the disease progresses.
4. It wanes in intensity as the lesion heals, but although it may reach a low level, it is rarely entirely lost, and then only with the complete eradication of all lesions within the body.
5. It is renewed by minor reinfections, so that a low allergy due to a sclerosed focus may be "boosted" to a much higher level by a subsequent reinfection.
6. It may be quickly reduced by anaemia, sepsis, intercurrent disease, pregnancy, any abnormal metabolic state, or by an overwhelming tuberculous infection.

Thus we see that allergy is an unstable attribute, subject to great changes in intensity. These fluctuations of allergy are of tremendous importance not alone from the decisive part which they play in the immunity or "resistance" of the host, but also from the fact that it is upon this variable allergy or hypersusceptibility that the common diagnostic reactions are based. With a knowledge of the fluctuations of allergy and some of the contributing causes therefor, one is in a position to explain many of the apparent discrepancies between clinical and laboratory findings and to correlate these several pieces of information into an opinion of reasonable value.

The above are the commonly accepted laws of allergy. The following description gives some of the characteristics.

Zinsser and Mueller[14] have shown that the development of tuberculin sensitiveness is definitely associated with tissue reactions in the form of

inflammatory processes, and is quite different from the usual antibody reactions such as precipitins, agglutinins, lysins, and complement fixation or such antibodies as are found in blood sera after ordinary bacillary invasions. Allergy can be produced only by the establishment of anatomic tubercle or the injection of tissue extract of tubercle, and can not be produced by the injection of dead bacilli except as they incite anatomic tubercle.

Baldwin[15], Zinsser[16], and Zinsser and Mueller[14] have further shown that allergy is not an anaphylactic phenomenon. The inciting substance (tuberculin) is not an ordinary coagulable protein, is not biologically altered by heat, and does not lose its properties on repeated alcohol precipitation. Anaphylactic hypersensitiveness is easily established in an uninfected animal by injection of dissociated tuberculoprotein, but such animals do not develop allergy. Conversely, infected animals are tuberculin sensitive within two weeks after injection without showing evidences of being anaphylactic until a week or ten days later.

Anaphylactic hypersensitiveness to tuberculoprotein is uniformly transmitted by inheritance through the female animal. No one has ever been able to record a similar transmission of allergy.

An anaphylactic reaction in a sensitive animal appears quickly after the injection of the protein-antigen and fades quickly without real tissue injury. A positive tuberculin reaction shows no immediate effect, but in four or five hours a swelling appears which progresses with oedema and inflammation often to a marked degree, and often with central necrosis and hemorrhage. The reaction reaches its height in twenty-four to forty-eight hours, and leaves profound tissue changes. Strickler[17] reports the histopathologic picture of a tuberculin reaction as presenting an acute inflammation, predominantly mononuclear, infiltrating the skin and subcutaneous tissues.

So much for the discussion of allergy, the altered tissue reaction capacity, which is the basis of the tuberculin reaction. When the *qualitative* intradermal test is found to be *negative*, one gains the knowledge that the patient, in the absence of massive acute tuberculosis, anaemia, sepsis, intercurrent disease or grave metabolic disturbance, has either escaped infection or the process of sclerosis has so walled off and obliterated the tubercle that the escape of focal material is nil and therefore the hypersensitiveness is diminished or lost. A *positive qualitative* reaction is interpreted as representing a focus, or foci, in which the investment of the tubercle is not so impervious and through which there is an interchange of focal material and body fluids, so that the generalized hypersusceptibility is maintained, and manifests itself in the skin in response to the tuberculin injection. If, in such a case, we can by means of a *quantitative* examination determine roughly the activity of these foci, we may be able to classify them in a manner which will be of value in diagnosis. Investigation of this problem in osseo-articular disease is the theme of the present paper.

It must be remembered that this test is one involving a biological response, attended with a number of variables, many of which are not

within our control—notably, the inherent fluctuation in intensity of allergy, the ever changing metabolic phase of the patient, heredity, environment, and other factors which always distinguish living from test-tube reactions. Furthermore an organism of divers strains and many grades of virulence is being dealt with which, in turn, produces varying degrees of tissue response.

No satisfactory method has yet been determined for the standardization of Koch's old tuberculin which is used in these tests, although studies, which Mueller [18-19] is carrying out, in separating the specific chemical elements of tuberculin, bid fair to obviate this difficulty. He has found a "nucleoprotein" or protein-like substance in tuberculin which will give skin reactions corresponding to those obtained with undissociated old tuberculin but to date this material is not available for general use. The common method of preparation of old tuberculin gives a product which, from a biochemical standpoint, is poorly suited for exact quantitative investigation. Consequently one specific lot of Saranac human tuberculin was used throughout the present series, eliminating this variable. The inconstancy in concentration of tuberculin, therefore, stipulates that the dilutions which we have found to be critical are only relative, and until some method of accurate standardization of the antigen is found, the quantitative examination of allergy will have a somewhat limited application, dependent upon the establishment of critical ranges of dilution for each new lot of tuberculin. Another element of difficulty is that high dilutions of tuberculin are supposedly unstable and must be freshly prepared, although we have found that a dilution of 1:1000 will keep for a month or more at ice-box temperature.

With these qualifications in mind, the problem resolves itself into an attempt to titrate, in the individual, the degree of sensitiveness to tuberculin which has been produced and maintained by a tuberculous infection. The antigen is tuberculin. The reactor element is the hypersensitivity of the tissues, initiated as a response to primary infection and carried on by the escape of focal material. The locale is the skin, chosen for the sake of convenience.

The technique consists of the injection at one sitting of one-tenth of a cubic centimeter of preparations of old tuberculin in the following dilutions: 1:1000, 1:2500, 1:5000, 1:7500, and 1:10,000. The above solutions may be made up in the various syringes as used, or, if a sufficient number of tests are to be made they may be prepared in the laboratory. The diluent used is saline with the addition of five-tenths per cent. phenol. The injections are evenly spaced on the volar surfaces of the two forearms and are accurately intradermal. The reactions are read in twenty-four and forty-eight hours and in six degrees of intensity.

The subject of scarring may be of some importance, for often brownish, scaly spots similar to a positive Schick reaction are the end results. The duration of the scar is not protracted, but as any discoloration on the forearm may be undesirable, some of the cases have been tested on the

adductor surface of the thigh with fairly satisfactory results. The skin here is thicker, however, and the reaction is not so delicate.

In the field of osseo-articular tuberculosis our efforts to measure allergy in a quantitative way and to establish a critical threshold which would separate the active from the inactive cases has been successful in a fairly comprehensive series.

In reporting our results, we are differentiating those cases above the age of twenty and those below, for cases above the age of twenty show in general a rather stable allergy which is much less likely to be affected by outside influences, while in children the fluctuations are apt to be marked. One must emphasize again at this point that the quantitative reaction is a biological test and as such it must be considered with other evidence in making a diagnosis. We do not feel that it in itself is entirely definitive. When high allergy is found it is, however, presumptive of a recent infection, but even if there is a suspicious bone or joint lesion we must rule out other foci of tuberculosis. Especially is this true in children with their common hilum and cervical node infections. Again, a low allergy may be present in even an active tuberculous case through the intervention of known factors such as anaemia, sepsis, intercurrent disease or the presence of an overwhelming tuberculous infection.

In our quantitative examination, fairly high dilutions have been used and apparently with this individual tuberculin there has been a critical threshold at 1:7500. In forty-three adults (Chart 1) studied at the Massachusetts General Hospital, presenting diversified non-tuberculous bone and joint disease, only three gave a positive reaction in the fifth or 1:10,000 preparation, making a percentage negative of ninety-three per cent. Of these three positive cases, one had moderately marked hilum tuberculosis. Another was the writer who has been found to be very highly sensitive on several occasions, possibly through the repeated handling of tuberculin. The third case is unaccounted for. On the other hand, in twenty adult cases (Chart 2) of clinically acute progressive and oft-times proved tuberculosis, all were positive in the fifth dilution, demonstrating a high allergy in one hundred per cent.

Below the age of twenty in cases studied at the Massachusetts General Hospital, New England Peabody Home, and the Children's Hospital, Boston, the results are almost as striking. In eighty-three cases (Chart 3) of non-tuberculous bone and joint disease, only nine gave a positive reaction with 1:10,000, a percentage negative of eighty-nine per cent. Of these positive cases several presented moderately marked hilum node findings. In sixty-five cases (Chart 4) of acute progressive tuberculosis of the bone and joint type, fifty-eight gave a positive reaction with 1:10,000, thus aiding materially in our diagnosis in ninety per cent. One of the negative reactors of this group, No. 277, illustrates perfectly the effect upon allergy of a superimposed sepsis.

The above patient presented a history of hip disease of nine months' duration following measles. An abscess had formed in the thigh two

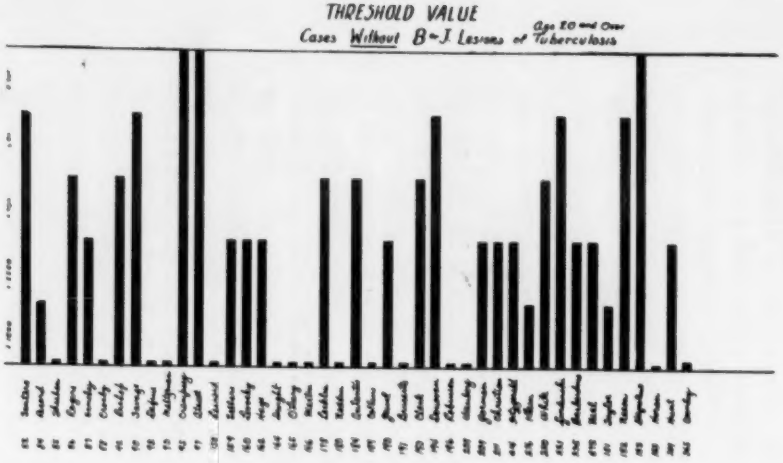


CHART 1

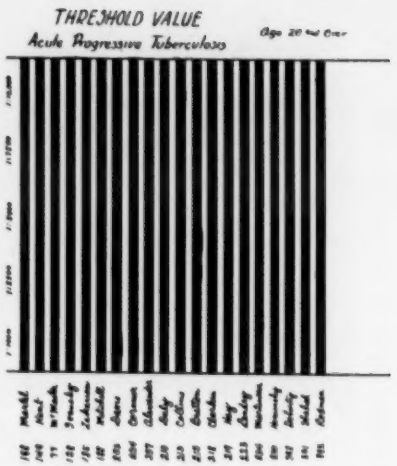


CHART 2

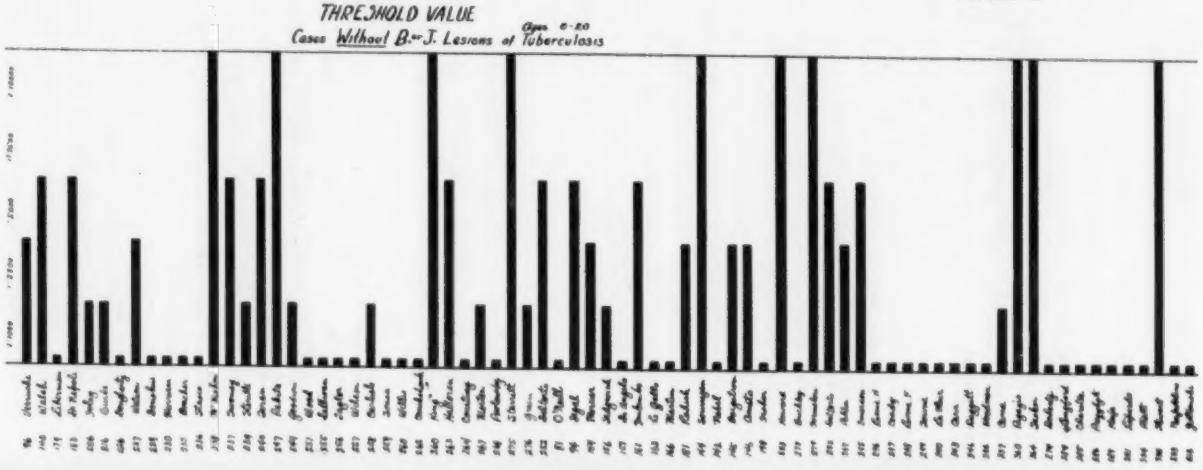


CHART 3

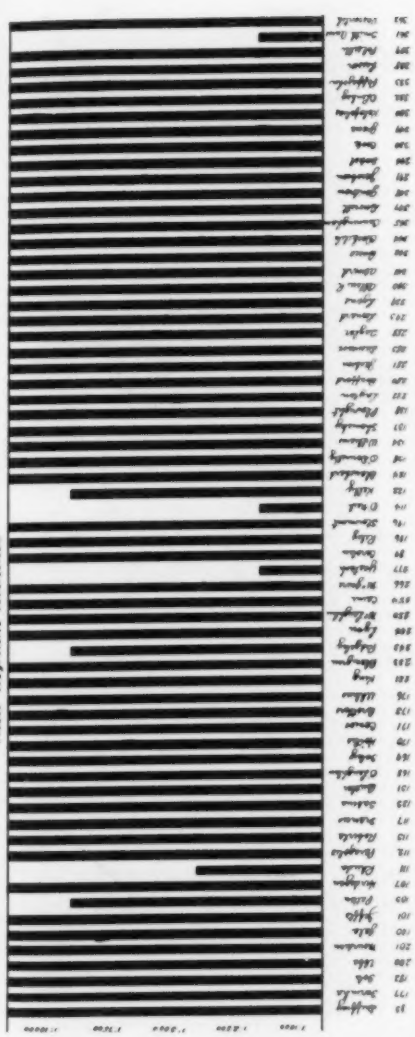


CHART 3

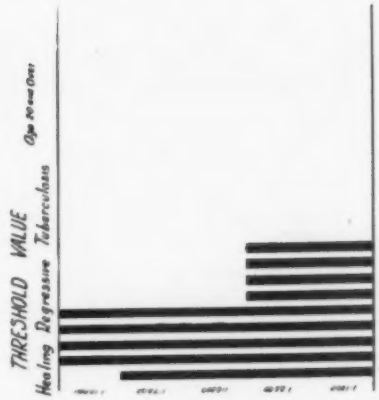


CHART 4

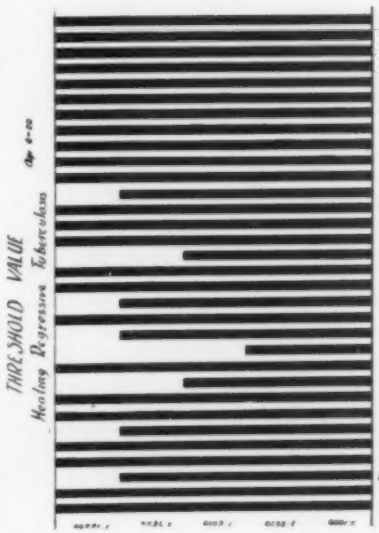


CHART 5

CHART 6

months previous to entrance, ruptured spontaneously under home conditions, and had formed a sinus. The inevitable sepsis had destroyed most of the head and neck with sequestration and the picture might well have been classed as osteomyelitis. The point at variance with this diagnosis was the history. Operation showed tuberculosis on a pathological examination. The tuberculin reaction was positive only at 1: 1000, indicating a moderately low allergy, illustrating without question the depressing effect of sepsis on allergy. It is possible that some of the other negative reactions are explainable on the same basis or by the fact that they may not belong in the acute progressive class, but should be in the healing regressive group.

One is now brought to a consideration of the tuberculin reaction in the type of case which may be designated, from its clinical course, as being healing, regressive bone or joint tuberculosis. In thirty-two cases (Chart 5) below the age of twenty, twenty-four cases or seventy-five per cent. showed a positive reaction and eight cases or twenty-five per cent. showed a negative reaction with 1: 10,000. The process in some of these patients was quite old and thus it is felt that a diminution in the strength of allergy should be expected. Similarly it was found that in nine adult cases (Chart 6), only four gave a marked hypersensitiveness, again showing the effect of sclerosis and healing on allergy.

In summarizing the above results it was found that, using 1: 7500 as the critical threshold in a series of 126 cases of various non-tuberculous bone and joint conditions, 114 or ninety per cent. gave a negative reaction, thus ruling out, with certain reservations, tuberculosis and reaffirming the clinical diagnosis. In eighty-five cases of acute progressive osseo-articular tuberculosis, seventy-eight were positive, confirming the diagnosis in ninety-two per cent. Among these eighty-five cases which were diagnosed clinically as tuberculosis, twenty-eight were proven by pathological or guinea-pig examination and all but one of these, the case above quoted, showed an allergy above the critical threshold. We feel that we have, therefore, by a special application of a well known diagnostic test, increased the efficiency of that test to the point where it has been proved to be at least ninety per cent. efficient in determining the presence or absence of acute tuberculosis.

## CONCLUSIONS

1. The tuberculin reaction is based on an hypersusceptibility of the skin and is an expression of an altered reaction capacity of the tissues, following an initial infection with the tubercle bacillus.
2. The strength of allergy fluctuates with the activity of the lesion and with the presence of certain qualifying factors.
3. It seems possible by quantitative examination to find a critical threshold which will usually establish a diagnosis in active tuberculous cases, although it must be considered that this evidence is only presumptive for osseo-articular disease until all other possible active foci have been ruled out.

4. In cases of bone or joint disease where the allergy falls below the critical threshold, and in the absence of certain modifying factors, active tuberculosis can, with fair degree of certainty, be eliminated in the diagnosis.

## REFERENCES


1. Moussu, G. and Mantoux, C.: Compt. rend. Acad. d. Sc. CXLVII, 502, 1908.
2. Krause, A. K.: Trans. Nat. Assn. Study and Prev. Tuberc. XII, 243, 1916.
3. Krause, A. K.: Am. Rev. Tuberc. I, 65, 1917.
4. Krause, A. K.: Am. Rev. Tuberc. III, 1, 1919.
5. Krause, A. K. and Peters, D.: Am. Rev. Tuberc. IV, 551, 1920.
6. Krause, A. K.: J. Outdoor Life. XVII, 170, 1920.
7. Krause, A. K.: Trans. Nat. Tuberc. Assn. XVII, 348, 1921.
8. Krause, A. K.: J. Outdoor Life. XVIII, 278, 1921.
9. Krause, A. K.: Am. Rev. Tuberc. IX, 83, 1924.
10. Krause, A. K.: Am. Rev. Tuberc. V, 994, 1922.
11. Krause, A. K. and Willis, H. S.: Trans. Assn. Am. Physicians. XXXIX, 86, 1924.
12. Zinsser, H.: J. Exper. Med. XXXIV, 495, 1921.
13. Zinsser, H.: Shattuck Lecture. 1925.
14. Zinsser, H. and Mueller, J. H.: J. Exper. Medicine. XLI, 159, 1925.
15. Baldwin E. R.: J. Med. Res. XXII, 189, 1910.
16. Zinsser, H. and Parker, J. T.: J. Exper. Med. XXXVII, 275, 1923.
17. Strickler, A. and Asnis, E. J.: Arch. Dermat. and Syph. VII, 379, 1923.
18. Mueller, J. H.: J. Exper. Med. XLIII, 1, 1926.
19. Mueller, J. H.: J. Exper. Med. XLIII, 9, 1926.


## DISCUSSION

Dr. F. C. Kidner, Detroit, Mich.: It seems to me that this paper of Dr. Atsatt's is of immense value to us all because I and many others have begun to lose faith in the tuberculin reaction. If we can gain more accurate knowledge, as seems possible by this technique, of the use of the tuberculin reaction and what to trust and what to distrust, we shall be in much better position than of late. That position has become so weak that it has been almost impossible for us to make a diagnosis in an infected joint without removing a specimen for examination. This is a dangerous procedure in tuberculosis and should not be done unless absolutely necessary. Dr. Atsatt's work seems to give us some new information. I should like to ask if he has any standardized preparation that can be used in the ordinary clinic. The present technique sounds difficult to carry out as a routine procedure.

Dr. R. B. Osgood, Boston, Mass.: Concerning a piece of careful research such as this there is very little to say in discussion. The degree of response is the essential thing. The basis of this work of Dr. Atsatt's is allergy. I call attention again to the statement made that allergy and anaphylaxis are not the same thing. The purpose of this research is to see whether with quantitative reactions we may be able to judge of the activity of the process by the sensitiveness of the tissues to this reaction.

I have found Dr. Atsatt's paper very stimulating not only because I think he has made a contribution, but because his interest was excited when he was a student. Even in the face of a great deal of difficulty his attention was sustained and during his post-graduate work he has made a definite contribution. I believe it is a real contribution because we have been trying out this type of reaction, not only when Dr. Atsatt was with us in Boston, but also after he left. Provided the tuberculin is properly standardized (and he gives us hope that it will be easily standardized in the future), much information can be gained. We gained the impression at the Children's Hospital that we

can estimate the activity of the process by this technique. That is a question we often want to decide, and most often in bone and joint cases.

Dr. Rodney F. Atsatt, Santa Barbara, Calif. (Closing the discussion): A point has been raised as to the very slight difference between the reaction in acute progressive tuberculosis and the reaction in healing retrogressive tuberculosis. We would expect only a very slight difference in the strength of the allergy between these two groups because both represent tuberculous disease in an active or fairly active state. However, in differentiating cases in which there is tuberculosis either of the healing retrogressive type or of the acute type and the cases in which there is no tuberculosis, there is a very marked variation in allergy, ranging in most cases around ninety per cent. That is where the value of this reaction comes in in differentiating between non-tuberculous cases and those which present tuberculosis, whether it be acute or healing.

Dr. Kidner asked for suggestions as to standardization of tuberculin. Dr. Müller of Harvard Medical School in conjunction with Dr. Zinsser has been working on a purified tuberculin that will give skin reactions. While he is not making it on a commercial basis, he hopes it will be possible to make it on a standardized basis. If that takes place we will be able to use tuberculin with accuracy. Koch's old tuberculin can be standardized fairly well by a laboratory technician in a very short time. First buy enough tuberculin of one lot so you will have enough to carry on for a year or two, then mix it all together to make a homogeneous tuberculin and take the different dilutions running from 1:1000 to 1:10,000 or 1:20,000 and try them on a series of tuberculous and non-tuberculous cases. Three or four will be enough to give an idea as to what range your tuberculin is going to fall in. The marginal threshold need not be definite. What we are doing is to look for indications of a high allergy and a high allergy in most cases will indicate active tuberculosis.

# ETIOLOGIC FACTORS IN CERTAIN CASES OF SO CALLED SCIATIC SCOLIOSIS*

BY ROBERT B. OSGOOD, M.D., BOSTON, MASS.

The inconclusiveness of this purely clinical paper is fully appreciated. We have encountered in the last few years a number of cases presenting fairly typical symptoms of the syndrome which has been called sciatic scoliosis. In these cases the mechanical etiologic factor supposedly so essential has seemed to be of minor importance in their causation and their treatment. Certain other etiologic factors have interested us greatly and we may say also surprised us greatly. In a somewhat cursory review of the literature, the following facts are brought out:

The name sciatic scoliosis seems to have been given the syndrome by Valentini in 1851. Kocher also used the term very early.

The best articles in English or any other language which we have found are by Bucholz in the *American Journal of Orthopaedic Surgery* in May 1913 and July 1914. His bibliography is very exhaustive. He concludes that it is not an anatomic entity as Denucé had concluded before him in 1899. He says that the great number of different theories which have been made to explain the pathogenesis and mechanical conditions of sciatic scoliosis give the impression that none of them has been sufficient. In his second article, reviewing 761 cases in which some affection of the sacro-iliac joints had been diagnosed, he found 174 with lists of the spine. He collected 105 cases. Of sixteen male patients presenting the syndrome of sciatic scoliosis which he examined and treated personally, only three cases showed very satisfactory improvement under mechanical therapy, and of nine females, the two with a slow onset showed no improvement. All the cases with a slow, insidious non-traumatic onset he believes have a poor prognosis. Yet these are cases which puzzle us.

Stein, in 1910, reviewed the theories of etiology and found they resolved themselves into two groups: one, the mechanical theories, and the other the purely neurological theories.

Sayre, in 1876, pointed out that scoliosis and sciatic pain were often associated with tuberculosis of the sacro-iliac joint. Goldthwait and Osgood recognized in 1905 that hypertrophic arthritis could produce the symptom complex, and Bucholz in his second paper believes that the different forms of arthritis play a distinct rôle as the underlying cause of sciatica

*Read before the Annual Meeting of the American Orthopaedic Association, Yosemite Valley, California, June, 1927.

and sciatic scoliosis and that neuritic processes play only a small part. Denucé, in 1913, recognized a typical case due to luetic spondylitis.

The etiologic factor which has intrigued us has been an arthritis of the low spine caused, we believe, by the absorption of toxic substances elaborated in the large intestine and associated with an intestinal stasis. We have not found this possible etiologic factor mentioned in literature.

We are fully aware of the controversial nature of this subject and of the ridicule which a clinical surgeon courts when he enters a field so well tilled by the labor of the physiologists and exposes himself to the effective shafts which they have forged in the furnaces of research.

In his cases of serious fracture, Hugh Owen Thomas, the great apostle of absolute rest, so inhibited the movements of his patients' bowels by morphia and a diet of milk and arrowroot that for two or three weeks there were no dejections. No harm seemed to follow this induced stasis. Let us observe, however, that the diet was all but starvation with little residue and that his patients were usually healthy dock laborers when the three weeks' stasis was induced. We are discussing a partial stasis which we believe may be of many months', perhaps years', duration. This type Hugh Owen Thomas also recognized. We do not shrink at holding apical tooth abscesses, ten millimeters in diameter, responsible for the elaboration of toxins capable of causing a generalized arthritis. It would seem rational to conceive it possible for patches of old faecal material clinging to the walls of the colon or retained in a backwater eddy of the caecum or imprisoned in a small pouch or diverticulum to elaborate toxins of comparable potency.

Does this type of stasis exist in many persons? We have no proof, but a strong conviction that it does. If your experience coincides with ours, and you will open at autopsy the colon of a patient whose bowels have been sluggish and who has been leading an inactive life, you may find such patches, which will still cling to the sides of the colon even when its flexible wall is manipulated under a strong stream of running water. In the case to which we refer we also found several small pouches containing hard, evidently very old, impacted faecal masses which were imprisoned within them.

We respect the wise clinician who allows his cases of habitual constipation to cure themselves by prescribing a rational diet and prohibiting the habitual use of laxatives and cathartics. Nature will finally rebel at intolerable conditions and fairly regular natural movements result. But does a daily dejection necessarily imply a complete evacuation? Is the colon regularly cleared of its entire contents or, as someone has said, may not the morning train arriving on time be the train which should have arrived a week ago?

Burnett has called attention to the phenomenon of too rapid elimination, and Drown, in an unlucky (or lucky) moment massaging the abdomen of a toxic patient, the cause of whose toxicity he suspected might lie in the colon, was so impressed with the result that his "*ergo propter hoc*" changed the whole course of his life. After a few similar experiences he gave up a

happy lucrative practice and until he died spent his life in massaging abdomens and irrigating colons, believing he had discovered the cause of many acute and most chronic ills.

Sir Arbuthnot Lane, Rea Smith, and Brewster have told us wonderful and true tales of relief following the excision of the colon. A distinguished professor of physiology remarked to me recently, "I am not convinced by any medical articles that the absorption of toxins from the intestinal canal does not occur. I can accurately predict when I shall have an attack of diarrhoea tomorrow by the way my finger joints feel today." His natural defense mechanism was efficient.

The first case which excited our interest and caused our amazement nearly twenty years ago was that of a practitioner of medicine in a New Hampshire city. He came to us fatigued after 1,000 consecutive days in his office, presenting a typical picture of Type I, rheumatoid, toxic or infectious polyarthritis. After searching for and eliminating or eradicating all possible focal infections,—teeth, tonsils, sinuses, genito-urinary tract, etc.,—we attacked a sluggish intestinal canal by methods of severe purgation by drugs and enemas as advocated by Jones of New York, whose writings and successes were then attracting attention. We employed in addition the correction of his body mechanics and what we believed to be a rational dietary and fresh air regime for over a month without avail. His disease progressed. We finally told him that we believed his disease was so far advanced that we were helpless. He made arrangements to return to his home permanently crippled. A few days before he was to leave the hospital, without additional therapy except, I believe, abdominal massage and more thorough colonic irrigation, he suffered a huge, quite unexpected movement of his bowels, consisting of dark, very offensive, obviously very ancient material, and began almost at once to have less pain in his joints. The articular and periarticular swelling subsided with surprising rapidity and after a few months of out-of-door life and a few manipulations to break up adhesions, he resumed his practice and has continued in it ever since. When his joints give him warning, he resorts to irrigations of his colon and he reports himself as well, happy and quite satisfied with life.

By present roentgenological study his stasis would have been probably suggested, but this large faecal mass in whatever portion of the colon it had its home must have been patent and perhaps the barium column would not have been significantly delayed.

It is customary in our community to give either a barium enema or a cleansing enema forty-eight hours or earlier after the ingestion of the barium meal and after the study of the stomach and small intestine has been made. We are finding numerous cases which, if this is not done, show retention of large masses of barium, sometimes in the caecum, sometimes in the transverse and descending colons seventy-two hours after its ingestion. We have every reason to believe it could often be found still later than this, but we have evacuated the material at this time because the proof of the stasis has been established and because of the discomfort which the patient

often suffers if it is allowed to remain longer. Seventy-two hours' study seems to us to be important and often revealing.

### TREATMENT OF INTESTINAL STASIS

We do not lay claim to any skill in the treatment of intestinal stasis. Our methods are to put the patient upon a non-constipating, dietary regime which will reduce an overweight to normal or just maintain a normal, following the suggestion of Pemberton as to the low caloric values of the so called carbohydrate intake and the diminution of the residue. We prescribe such a combination of recumbency with the foot of the bed elevated, positions, exercises and exercise, as we believe will correct faulty body mechanics, applying often an abdominal pad or light brace to maintain the correction of ptosis when the patient is ambulatory. We administer by mouth mineral oil and agar which, if not sufficient to induce free daily movements, are aided by such cathartics as senna, licorice powder or even castor oil. Colonic irrigation and sometimes oil enemas are given, perhaps at first every day and later every other day or twice a week. We teach the patients Drown's method of abdominal massage or have our physiotherapist perform it daily. This method consists of kneading by gentle pressure and circular motion the contents of the colon in the *left* iliac fossa, hoping to pass it into the sigmoid. Then at a point roughly half way toward the splenic flexure we repeat the procedure and stroke our softened material toward our starting point. At the splenic flexure, at a point half way between the flexure and the umbilicus, at the umbilicus, at a point half way between the umbilicus and the hepatic flexure, and at the hepatic flexure we repeat the massage along the course of the festooned transverse colon. Each time as we finish massaging an area we stroke backwards along the course of the colon toward and to the left iliac fossa. Thus we continue downwards at a point half way between the hepatic flexure and the caecum, again returning to the left iliac fossa, and finally thoroughly massage the caecum in the right iliac fossa and return to the left. This procedure occupies ten to fifteen minutes, depending upon the rigidity and spasticity of the colon. The patient must learn to relax the abdominal muscles. Flexing the thighs usually aids in this relaxation.

The following six brief case reports with duration of symptoms from four years to four months seem to suggest that in them an etiologic association existed between intestinal stasis, the absorption of toxins and the symptom complex known as sciatic scoliosis. It will be noted that in four of the cases a marked anatomical variation coexisted. The situation of this vertebral abnormality in two was entirely appropriate to its consideration as an important etiologic factor.

### ILLUSTRATIVE CASES

CASE 1.

Mr. R. N., aged twenty-two, college student. Seen first Aug. 16, 1922.

*Complaint:* Pain in low back and left leg.

*Duration:* Three and one-half months.

*Cause:* Unknown, possibly strain in rowing on Harvard Varsity squad.

*Family History:* Negative.

*Past History:* General good health; bowels very regular without medicine; very athletic; no venereal history.

*Present Illness:* Pain in back and left leg noticed three and one-half months previously, chiefly in getting up after long sitting. This did not interfere with his rowing. Can swim and dive, but the condition is becoming more troublesome. Has had six osteopathic treatments without improvement.

*Physical Examination:* General examination negative. Well developed man, standing with slight deviation of spine to left. Motions of spine restricted, freer to right than left. Lying leg raising with knee straight only few degrees on left. Reflexes, sensation, and all other joint motions normal. No nerve trunk tenderness. Abdominal examination negative, except for heavy abdominal muscles.

*Roentgenologic Findings:* Six lumbar vertebrae and enlarged right transverse process of the last lumbar.

*Diagnosis:* Strain of low back at area of lessened resistance.

*Treatment:* Low back brace.

*Course:* Sept. 15, 1922 (one month). Slightly better.

Jan. 17, 1923 (five months). Condition remains the same. *In left iliac fossa sausage-shaped mass felt.* Pressure on this increases sciatic pain.

March 14, 1923 (seven months). Unrelieved. Jacket applied.

June 1, 1923 (ten months). Only slightly relieved by jacket. Consultation with Dr. J. E. Goldthwait and Dr. John C. Wilson. Original diagnosis confirmed. No evidence of tuberculosis. Patient allowed to take European summer trip with removable jacket and brace.

Sept. 16, 1923 (thirteen months). Returns from European trip much worse. Tenderness along sciatic nerve trunk. Looks pale and pasty. Rigid scoliosis and forward flexion of spine more pronounced. Bowels are not moving as regularly. *Fullness in left costovertebral angle and left iliac fossa noted.* Thorough review by internist, including the examination of the stools, reveals nothing. Barium roentgenological series reveals marked seventy-two-hour residue and spastic colon.

Sept. 21, 1923. Patient enters hospital for recumbent treatment. Cathartics by mouth, colonic irrigation, abdominal massage and exercises in recumbency started. Light diet, low in carbohydrate calories, prescribed. Sweat baths twice a week. Large results from enemas.

Oct. 19, 1923 (one month). Condition the same. Material obtained from enemas still shows much fermentation. *Sciatic pain usually made worse by abdominal massage.*

Nov. 20, 1923 (two months). Conditions the same. Still much foul faecal matter obtained by enemas. Patient has had a huge, unexpected, voluntary movement of the same character, the passage of which made him faint.

Jan. 28, 1924 (four months). Very marked and rapid improvement since the large evacuation of the last note. The deviation of the spine and the sciatic pain have disappeared and he can walk three miles without discomfort.

Two months later the bowels backed up again and his old symptoms returned, but disappeared in five days with a return to colonic irrigations and abdominal massage. With close attention to his diet and abdominal massage he has remained entirely well for four years and is working hard at life insurance in New York.

*Comment.* The case illustrates an original faulty diagnosis and an unavailing treatment along mechanical lines. Neither the history nor the early physical examination suggested the etiological factor of intestinal stasis which seemed later to be almost proved.

CASE 2.

Mr. H. G., aged eighteen, college student. Seen first July 2, 1923.

*Complaint:* Pain in the low back and right leg.

*Duration:* Subacute two months, acute two weeks.

*Cause:* Unknown.

*Family History:* Mother and father have both had occasional slight sciatica.

*Past History:* General fair health. Typhoid at four. Subject to grippe-like attacks; bowels always constipated; moderately athletic; no venereal history.

*Present Illness:* For two months stiffness in back after sitting in classroom, with occasional pain down right leg. For two weeks, without accident but during activity, more acute and sharp low back and right leg pain and slight left leg pain. Interference with sleep.

*Physical Examination:* General examination negative. Sallow complexion. A little under weight. Standing with deviation of the spine to left. Spinal motions all restricted. Lying leg raising with the knee straight restricted on the right to ten degrees, half normal on the left. Reflexes, sensation and all other joint motions normal. No nerve trunk tenderness. Abdomen feels unemptied and spastic. Careful examination by internist, including blood, urine and stools, negative for foci except abdomen and a slight systolic murmur.

*Roentgenologic Findings:* Marked anatomic variation with enlarged transverse process articulating with the sacrum on the right.

*Diagnosis:* Anatomic variation causing area of less resistance and toxic arthritis.

*Treatment:* Rest. Plaster jacket. Catharsis.

*Course:* Sept. 4, 1923 (two months). Some improvement but not marked. Seen in consultation with internist, Dr. W. H. Smith of Boston. Diagnosis of arthritis confirmed, with intestinal stasis as etiologic factor. Fifteen minims castor oil after noon and evening meal. Mineral oil and agar and licorice powder sufficient to move bowels freely. Colonic irrigations. Abdominal massage. Short back brace.

Oct. 2, 1923 (three months). After abdominal massage, movements are much more copious. One enema of two quarts resulted in four-quart evacuation of much fermented material. Much less pain. Great improvement in color and spinal flexibility.

Nov. 27, 1923 (five months). Rather sudden abeyance of symptoms concomitant with evacuation of large amounts of clay-colored material. Spinal motions still restricted.

Jan. 1, 1924 (seven months). Condition remains as at last note, except that spine is regaining flexibility. Occasional old faecal matter passed after abdominal massage. Postural exercises begun.

May 1924 (ten months). Color normal. No symptoms. Driving automobile, dancing. Slight deviation of the spine to the right as he bends forward. Bowels sluggish without oil and agar and enemas.

March 1926. Has been well for over a year, playing squash regularly and wearing no apparatus. To enter Military Training Camp.

*Comment.* In this case the history of constipation and the findings suggested intestinal stasis as a possible etiologic factor. The marked and appropriately situated vertebral abnormality led us to suspect this also and might have suggested operative attack. In light of the subsequent history, this operative attack would have been unjustifiable and probably futile.

CASE 3.

Mr. V. M., aged twenty-three, farmer. Seen first Sept. 4, 1925.

*Complaint:* Pain in the right leg.

*Duration:* Four years.

*Cause:* Unknown.

*Family History:* Negative.

*Past History:* General robust health; tonsils and adenoids removed in early life; bowels very regular without medicine; very athletic; no venereal history.

*Present Illness:* Frequent attacks of pain in the right leg for the last four years. Football in college only suspected cause. Able to do hard work as a farmer until one year ago with avoidance of heavy lifting. Medicines, osteopathy, chiropractic without relief. One week before being seen, more acute pain and interference with sleep.

*Physical Examination:* General examination negative. Tall, finely built, heavy man standing with slight deviation of the spine to the left. Almost no motion in for-

ward bending. Lateral spinal motions freer. Lying leg raising with the knee straight twenty degrees on right, nearly normal on left. Reflexes, sensation and all other joint motions normal. No nerve trunk tenderness. Abdomen full, spastic, but no discrete masses.

*Roentgenologic Findings:* Large transverse processes of last lumbar and asymmetrical lumbosacral facets.

*Diagnosis:* Intestinal toxaemia and possible back strain.

*Treatment:* Short back brace. Oil and agar by mouth. Enemas, abdominal massage. Light diet, low in carbohydrate calories.

*Course:* Oct. 4, 1925 (one month). Great improvement in all symptoms. Sleeping well. Straight leg raising thirty-five degrees on the right (cf. with twenty degrees, first note). Large results from enemas. Abdomen feels softer.

Nov. 4, 1925 (two months). Improvement continues. Straight leg raising on the right fifty degrees. Motions of the back much freer. Results from enemas continue. Postural exercises begun.

Jan. 6, 1926 (four months). Only occasional fleeting symptoms. Can sit in bath tub with legs flat. Resumption of light farm work.

Jan. 2, 1926 (nine months). No symptoms. No deviation of spine. Right straight leg raising a little less full than left, but nearly normal. Intestines feel well emptied. Has been doing hard farm work for several months. Brace continued as a precaution during work. Considers himself well.

*Comment.* The case illustrates a rather quick relief from an intermittent discomfort of four years' duration and crippling pain and stiffness of one year. The overcoming of an unsuspected intestinal stasis seems to have been the chief factor in this relief. Anatomic variation was present, but apparently was not an important factor.

CASE 4.

Mr. R. A., aged twenty-five, farmer. Seen first October 26, 1925.

*Complaint:* Pain in the low back and right leg.

*Duration:* Four years.

*Cause:* Unknown, said to have followed heavy ploughing.

*Family History:* Negative.

*Past History:* Never very strong. Always thin. "Canker" in mouth two years ago. Bad complexion. Eczema. Bowels regular without medicine.

*Present Illness:* Four years ago after heavy ploughing and possible wrenches of his back, he was laid up for three weeks with pain in his low back and right upper leg. He apparently recovered after rest, but ever since this attack, on strenuous work the pain in his back and leg returned. For the last three months, although his labor has not been specially hard, the pain has been worse and has interfered with sleep. He has tried medicines and liniments without relief.

*Physical Examination:* General examination negative. Slender, anxious-looking man with bad complexion, standing with marked deviation of the spine to the right. Bad postural stance, ptosis. Lumbar spine very flat. Motions restricted in all directions. Right straight leg raising twenty-five degrees. Reflexes, sensation and all other joint motions normal. Abdominal wall thin. Many masses to be felt and considerable spasm. No tenderness along nerve trunks. No other surgical foci found.

*Roentgenological Findings:* Dense shadow in caecal region. No vertebral abnormality.

*Diagnosis:* Intestinal toxaemia and low back strain.

*Treatment:* Short back brace, oil and agar, enemas, abdominal massage. Light diet, low in carbohydrate calories.

*Course:* Nov. 27, 1925 (one month). Less sciatic pain, less deviation of the spine. Motions of the spine freer. Normal lumbar curve returning. Abdomen softer. Complexion clearer.

Dec. 28, 1925 (two months). Less well for last week. Complexion worse. Abdomen more spastic and return of masses. Has not been regular with abdominal massage and enemas. Told to return to more efficient eliminative treatment. Sweat baths twice a week.

Feb. 8, 1926 (three and one-half months). Only occasional symptoms. Only slight deviation of the spine. Motions freer. Postural exercises and muscle-developing exercises begun.

July 13, 1926 (nine months). No symptoms. Suggestion of deviation of spine correctible voluntarily by patient. Right straight leg raising not quite as free as left. Complexion clear and color good. Has returned to full farm work for several months without apparatus. Patient says he is perfectly well.

*Comment.* The case illustrates an original known strain of the back never entirely relieved, with a toxic arthritis probably of intestinal origin superimposed. A combination of causes demanding a therapy which attempted to overcome both the faulty mechanics and the intestinal stasis.

CASE 5.

Mrs. E. C., aged thirty-eight, housewife. Seen first Oct. 17, 1925.

*Complaint:* Left hip and leg.

*Duration:* Three months.

*Cause:* Unknown.

*Family History:* Negative.

*Past History:* Generally well and athletic. Menstruation regular. Bowels usually regular without medicine. Tonsils removed twice. One attack of acute abdominal pain. Question of kidney stone (Mayo Clinic). Minor gynaecological operations. Two years ago slight attack of low back pain relieved by strapping and exercise. Broken ankle six months ago. Long convalescence. Gain in weight. More sedentary life.

*Present Illness:* Three months ago after sitting on the ground with legs straight, felt pain in her left leg. Diathermy, exercises, osteopathy unavailing. Better in bed. Diagnosis of arthritis of spine made by family physician.

*Physical Examination:* General examination negative. Well developed woman, standing with slight deviation of spine to left. Motions of the spine in forward and lateral bending to the right restricted. Straight leg raising restricted on left to thirty degrees. Tenderness to pressure over lumbosacral and sacro-iliac joints. Tenderness over the sciatic nerve in the thigh. Reflexes, sensation and all other joint motions normal. Abdominal examination inconclusive. No other surgical foci found.

*Roentgenological Findings:* Marked anatomic variation. Enlarged transverse process and sacrotransversalis joint on left.

*Diagnosis:* Low back strain due to anatomic variation and prolonged convalescence, possibly an arthritis and neuritis due to intestinal toxaemia.

*Treatment:* Short back brace, exercises, oil and agar and abdominal massage on chance of stasis.

*Course:* After a week's observation during which the patient improved considerably and the sciatic tenderness almost disappeared, she returned to her home in the West with a letter to her local physician advising exercises, a gradual resumption of her normal activities and special attention to the bowels.

Not seen again until Sept. 8, 1926 (eleven months). After reaching home her improvement had continued for a few weeks; then there was a return of her symptoms on resumption of activity uncontrolled by brace, diathermy, exercises, rest or medication. Loss of morale and general depression ensued. Some betterment during the last month has occurred, since she has been put on a Pemberton diet low in carbohydrate calories. The physical examination at this time is the same as at the first examination and a barium series shows a sixty-six-hour residue. A gynaecological examination is negative. She is put to bed, given oil and agar regularly by mouth, occasional doses of castor oil, or senna, colonic irrigations, abdominal massage. Sweat baths twice a week.

Oct. 22, 1926. (six weeks). Marked improvement. Only occasional sciatic pain. Sciatic scoliosis nearly gone. Postural and muscle-developing exercises begun.

Dec. 20, 1926 (three and one-half months). Discharged to spend winter in Arizona with heliotherapy and resumption of activity.

March 1927 (six months). Able to drive in auto eighty miles; walks four to five

miles. Bowels need constant attention, but with senna, enemas and abdominal massage patient remains well.

*Comment.* This case illustrates the placing of too little importance upon a suspected intestinal stasis and too much importance upon attitudinal strain and an appropriately located vertebral abnormality. It would have been better if the suspected stasis had been proved early rather than late and had been treated intensively from the start. Nearly a year of treatment would have been saved.

CASE 6.

Mr. E. W., aged forty, salesman. Seen first Jan. 3, 1927.

*Complaint:* Pain in low back and left leg.

*Duration:* Three to four months.

*Cause:* Unknown.

*Family History:* General good health; nervous breakdown four years ago; bowels regular without medicine; no venereal history.

*Present Illness:* Three months ago while carrying a thirty-five-pound bag, began to notice pain in back. One month ago the pain increased in intensity and pain began in the left leg. Obliged to give up work. Back strapped with some relief. Acute pain on coughing or sneezing. Pain when seen interfered with sleep.

*Physical Examination:* General examination negative except for poor teeth. Rather poorly developed, thin, pale man standing with slight deviation of the spine to the right and a kyphotic lumbar spine rigid to all motions. Straight leg raising only slightly limited on either side. Reflexes, sensation and all other joint motions normal. No nerve trunk tenderness. Abdomen more full and tense than normal. Evidently unemptied.

*Roentgenological Findings:* Spina bifida occulta and partly lumbarized first sacral segment; obscuration of sacro-iliac joint lines.

*Diagnosis:* Arthritis of the low spine, probably toxic, but possibly tuberculous.

*Treatment:* Short back brace. Oil and agar by mouth. Enemas, abdominal massage. Sweat baths twice a week. Roentgenograms of teeth by dentist and appropriate treatment advised.

*Course:* Jan. 14, 1927 (eleven days). Large results from bowels. Much less pain. Spine more flexible. Lumbar kyphosis gone. No attention to teeth as yet.

Jan. 28, 1927 (twenty-five days). Improvement continues. No sciatic pain. Almost no deviation of the spine. Motions freer. Can sneeze without pain. Abdomen feels well emptied. Two teeth have been removed. Postural exercises begun.

March 21, 1927 (eleven weeks). No deviation of spine. Motions nearly normal Has no pain. Has gained six pounds and returned to his regular work as a salesman.

*Comment.* The case illustrates the fortunate speedy recovery of an early case treated by moderate protection and by measures appropriate to relieve a toxaemia which we believe to have been caused by faulty alimentation.

## BIBLIOGRAPHY

For full bibliography up to 1912, see: BUCHOLZ, C. HERMANN: A Study of the Condition Frequently Called "Sciatic Scoliosis". Am. J. Orth. Surg., X, 528, May 1913.

ARNOLD: Ueber Scoliosis ischiadica. Inaug. Diss., Erlangen, 1903. Abst. Ztschr. f. orth. Chir., XIII, 195, 1904.

BLENCKE, HANS: Die Scoliosis ischiadica alternans. Arch. f. orth. u. Unfall.-Chir., XVIII, 63, 1920. Abst. J. Orth. Surg., III, 646, Nov. 1921.

BRADFORD, E. H., AND BRACKETT, E. G.: Scoliotic Sciatica. Boston Med. and Surg. J., CXXXII, 132, 1895.

BUCHOLZ, C. HERMANN: Further Studies of the So Called "Sciatic Scoliosis". Am. J. Orth. Surg., XII, 90, July 1914.

CALISSANO, G.: Su di un caso di scoliosi sciatica alternante. Chir. degli Organi de Movimento, IX, 158, 1924.

DENUCÉ: La soi-disant scoliose sciatique. Rev. d'orthop., IV, 531, Nov. 1913.

DUCAMP AND CARRIEU: Scoliose alternante d'Origine sciatique. Bull. et mém. Soc. méd. des hôp., XLIV, 265, 1920.

GUSE: Ischias scoliotica. Wien med. Presse, XXXV, 1149, 1894. Abst. Boston Med. and Surg. J., CXXXIV, 342, 1896.

HAGLUND, P.: Sciatic Scoliosis. Acta med. Scandinav., LVI, 658, 1922. Abst. J. Am. Med. Assn., LXXIX, 1808, 1922.

HOFSTEIN: Ueber Scoliosis ischiadica. Diss. Freiburg. 1907. Abst. Zentralbl. f. Chir. u. mech. Orth., II, 67, 1908.

LÉRI, ANDRÉ: Scoliosis with Sciatica. Bull. et. mém. Soc. méd. des hôp., XLIII, 758, 1919. Abst. J. Am. Med. Assn., LXXIII, 1644, 1919.

PLATE, E.: Origin and Treatment of Scoliotic Sciatica. Deutsche med. Wchnschr., XXXVII, 116, 1911. Abst. J. Am. Med. Assn., 627, 1911.

SACHS, W.: Ischias Scoliotica. Arch. f. klin Chir., XLVI, 684, 1893. Abst. Ann. Surg., XIX, 751, 1894.

STOLZ: Ueber Scoliosis alternans ischiadica. Berlin. klin. Wchnschr., XLVIII, 236, 1911. Abst. Am. J. Orth. Surg., IX, 287, Nov. 1911.

NOTE:—Discussion of this paper will appear in a later issue of the *Journal.—Editor.*

# INTERNAL DERANGEMENT OF KNEE JOINT*

BY JAMES O. WALLACE, M.D., AND H. H. PERMAR, M. D., PITTSBURGH, PA.

This paper is a study of seventy-one cases in which arthrotomy has been done for internal derangement of the knee joint. The object is to present the latest knowledge of the anatomy and physiology of the joint and the actual pathology as seen and obtained at operation. An attempt will be made to correlate and explain clinical symptoms and findings with pathologic anatomy and physiology and to develop a better understanding of the treatment of these cases.

It will be shown that a great majority of cases of chronic joints are due primarily to some mechanical derangement of the knee joint which has been unrecognized or has had faulty treatment. They are not caused as a rule by direct bacterial infections or as the results of toxins of bacterial origin.

Normal structures such as semilunar cartilages and fat pads, when separated from their normal positions, become "foreign bodies" and until replaced or removed act as irritants which set up inflammatory cycles.

In a discussion of the pathology of knee-joint injuries with associated dislocation of the semilunar cartilages, it may be well to begin with a brief review of the structure and function of the joint.

The knee is not a simple hinge joint. It has three articulations, the condyles of the femur with the tuberosities of the tibia, and the femur with the patella. In certain animals (Gray[1]), there are three synovial sacs, and in man this is true in the embryo. During development they fuse to form a single cavity, the largest and most complicated synovial sac in the body. Its various subdivisions need not be detailed here (Fig. 1). The sac is lined by synovial membrane and has a row of villus-like processes (the haversian fringes), extending into it. These arise from the synovial membrane about the edges of the articular surfaces. The free upper and lower surfaces of the semilunar cartilages are also covered by the synovial membrane.

The semilunar cartilages are sickle-shaped, with the broad, convex margin attached to the joint capsule and the narrow concave margin extending free toward the joint cavity. They lie between the bones, though actually outside the synovial sac. They are loosely attached to the top of the tibia, so that normally there is a slight movement of the cartilages on the head of the tibia. The cartilages may be likened to the shims in a universal joint; they enlarge and deepen the articular surfaces. Further, being elastic and loosely attached, they change in shape with different

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

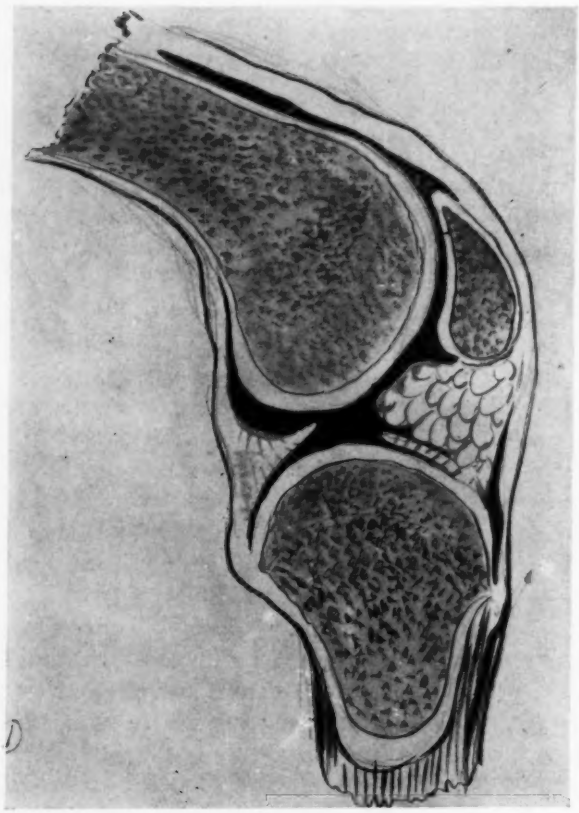

FIG. 1

Schematic sagittal section of the knee joint to show the shape of the synovial sac. It is shown in black, and is exaggerated. (After Gray.)

movements, becoming longer and thinner in extension and thicker and shorter in complete flexion.

The blood supply to the synovial membrane is fairly rich, as shown in Figure 2, which illustrates an injection of the circulation in the knee joint of the new-born. The circulus articuli vasculosus and the blood supply of the parietal portions of the synovial sac take origin from branches which penetrate the joint at the attachment of the lateral ligaments, above and below the articulating surfaces. The articular cartilage normally derives most of its blood supply from osseous branches which penetrate the head of the bone and supply the deeper growing layer of cartilage. The surface layer of articular cartilage is avascular.

The wall of the joint consists of the fibrous capsule and the synovial membrane. The capsule and its ligaments will not be discussed. The synovial membrane is composed of (1) synovial lining cells, (2) loose connective tissue with special mucin-forming cells, (3) adipose tissue, (4) blood vessels, (5) lymphatics and (6) nerves. These elements are not uniformly distributed. The synovial membrane lines the entire cavity, including the margins of the articular cartilages, where it acts as the perichondrium; but it is lacking over the weight-bearing areas, which are simple avascular cartilages. As William Hunter pointed out nearly 200 years ago, no blood vessels could exist in areas subject to constant direct pressure; and the same is apparently true for a specialized lining cell layer, since there is none demonstrable.

The synovial lining cells are present throughout the sac, but not as a complete sheet. They are lacking in many areas. There are two opinions

as to their nature. Key[2] maintains that they are specialized fibroblasts, but most texts (Lewis and Stöhr[3], Schäfer[4], and Ferguson[5]), and the majority of recent writers, as Fisher[6, 7] and Jones[8], consider them specially differentiated lining cells and term them endothelium or mesothelium. Since the lining is incomplete, it follows that the connective tissue layer is in direct contact with the joint cavity at some points.

FIG. 2

The blood supply of the synovial membrane of the knee of a new-born child. Prepared by injections. (After Fisher.)

The connective tissue, which forms the important supporting substance of the synovial membrane, is present throughout the synovial sac. The striking feature of its structure is the mucin-producing cells which are present in considerable numbers. They chiefly lie very close to the surface of the membrane, and are especially numerous in the villous processes fringing the articular margins. These cells are to be considered specialized connective tissue cells. They are round or oval, take a deep stain and show in their cytoplasm vacuoles which represent droplets of mucin. The vacuole is often single, and large enough to resemble a fat cell. They are often found in groups with the cells piled several layers deep; and, as they lie near the surface, may resemble a type of epithelium. These cells produce the viscous element of the synovial fluid, their mucinous secretion being expressed by normal pressures. It passes directly into the joint cavity from the superficial cells, while from the deeper cells it passes first to spaces in the loose connective tissue and reaches the cavity through the stomata in the lining layer.

The connective tissue supporting the lining and secreting layer is supplied at all points where "packing" is required by masses of adipose tissue, of which the infrapatellar fat pad is an example. And in some of

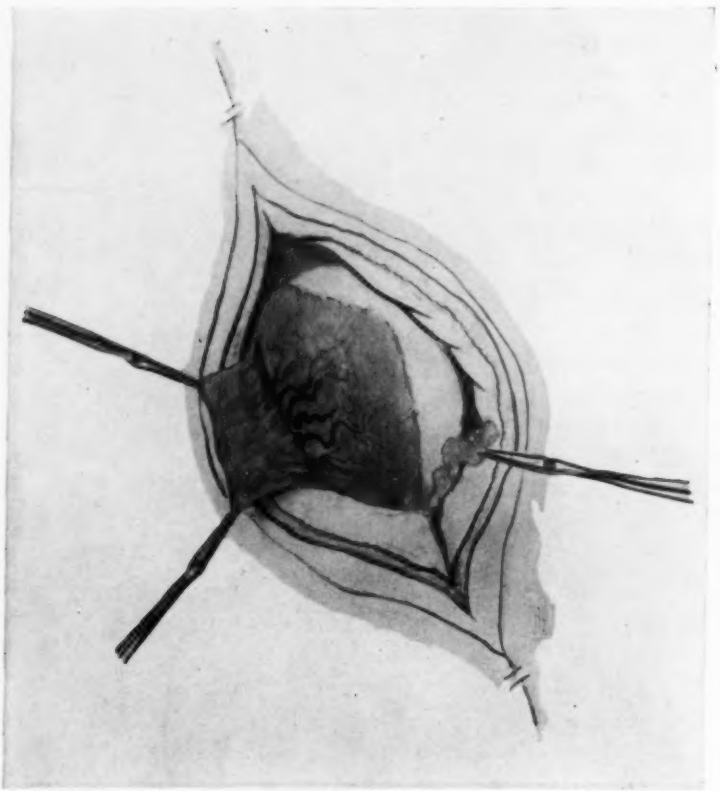

FIG. 3

Pannus formation on the articular surface of the femur. Drawn from life.

these, such as the infrapatellar pad, there are found so many collections of mucin-producing cells that the term synovial glands (of Clopton Havers), seems almost justified.

The synovial membrane is supplied with a rich plexus of capillaries from which normally there is a constant transudation of albuminous fluid into the joint. The synovial fluid is thus composed of a mucoid substance from the specialized connective tissue cells and an albuminous fluid derived from the plasma, the latter containing substances for the nourishment of the central, avascular part of the articular cartilage. The fine capillary blood supply of the synovial membrane is of particular interest and importance in the present study, since it is from this that the granulation tissue (pannus) is developed over the previously avascular cartilage in chronic injury (Fig. 3). Lymphatics may be clearly demonstrated by injection experiments. Enervation is supplied by a rich plexus of fine nerves with peculiar end bulbs partly scattered in the connective tissue and partly grouped in plexuses near the lining membrane. There are also some new endings of the pacinian corpuscle type.

FIG. 4

FIG. 5

Resected semilunar cartilage, showing gross injuries to semilunar cartilages.

FIG. 6

FIG. 7

Resected semilunar cartilage, showing gross injuries to semilunar cartilages.

The foregoing details are derived largely from the recent publications of Fisher, whose work has been verified by us in so far as it touches our problem. He notes two additional points in the function of the synovial membrane. First, that it is capable of absorbing fluids of various types, whether true solutions, colloids or suspensoids, but with varying facility in the different types. And second, that the presence of a foreign body in a joint causes a synovial reaction, resulting eventually in its attachment to the villi, after which it is enveloped by newly formed connective tissue. Further, the connective tissue so produced tends to differentiate as cartilage, thus explaining the formation of the commoner type of joint mice.

The dislocated semilunar cartilage is in fact a foreign body in the joint cavity, and the reactions which follow this mechanical derangement are essentially the same as those to a foreign body. However, if the cartilage is replaced and rest allowed, repair is usually complete. It is the chronically and recurrently dislocated cartilages that give the extensive joint changes. Under dislocation, one must consider longitudinal splitting of the cartilage, often with displacements of the inner fragment in an angulated position, as well as the occasional transverse fractures occurring in the cartilage at the time of injury, with resultant displacement of the two fragments (Figs. 4, 5, 6 and 7). The immediate results are probably relatively mild, being the picture of aseptic inflammation with congestion,

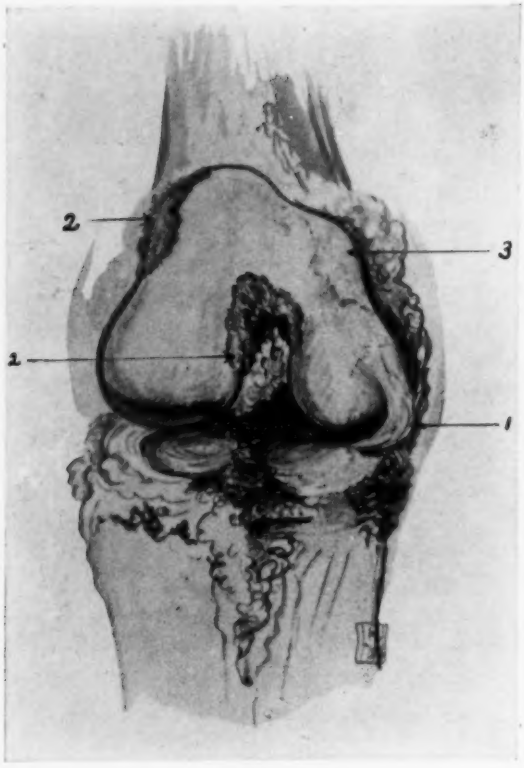


FIG. 8A

Semilunar cartilage dislocated and adherent to femur. Much pannus formation, which has been curetted from one condyle, showing well preserved cartilage beneath. Drawn from life.

1. Torn cartilage attached to condyle.
2. Pannus formation.
3. Pannus formation removed, showing cartilage.

serous exudate and perhaps some cellular exudate. In the long standing and recurrent dislocations, quite marked changes are produced. These involve chiefly the synovial membrane with its fringes, and include hyperplasia or granulation tissue-like overgrowths of the membrane, and congestion, vascularization and fibrosis of the fat pads. There is also a fibrous thickening about the injured semilunar cartilage, which may be extreme. This last is a simple process and does not require further mention. There is always an increase in the joint fluid, which varies in color and consistency.

The proliferative inflammatory changes in the synovial membrane give rise to the development of a type of granulation tissue in a sheet over the normally smooth and glistening articular surface. This new tissue (called a pannus), is soft and velvety or mossy in texture, a dull red in color and forms a triangular or sector-shaped patch. The pannus formation, then, is an inflammatory hyperplasia of the injured synovial membrane, and the production of new granulation tissue, extending over areas in the joint cavity where synovial membrane is lacking normally. Since any increase in the blood supply must be derived from the vessels at the margins of the articular surfaces, the development of hyperplasia and granulation tissue begins at the edges and gradually progresses over the previously avascular weight-bearing area of the cartilage. It is remarkable how little injury of the articular cartilage takes place under a well developed pannus (Figs. 8A, 8B, 8C), although in extreme cases it is pronounced and in the end will lead to complete destruction of the articular surface.

The microscopic picture is one of marked thickening of the normal loose connective tissue beneath the synovial membrane, with a great

increase in the number and size of small vessels, especially of capillaries. The free surface is cast into short villous projections, each of which has its stroma and vessels. The lining of mesothelium is maintained, as suppuration does not occur. The mucin-producing cells increase in number and are found throughout, lying just beneath the free surface. Inflammatory cell exudate is variable, but always present to some degree. It consists of lymphocytes and plasma cells, located in small clumps about the vessels (Fig. 9). While nerves and sensory endings were not found by us in our sections, the inflammatory chances just described explain the frequency of pain and localized tenderness as symptoms in these cases.

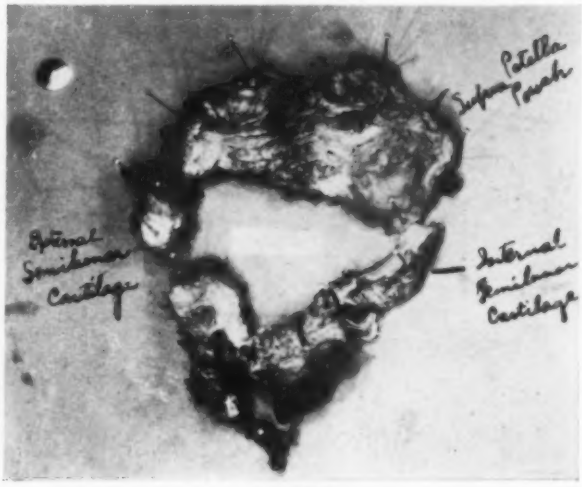


FIG. 8B
Tissue removed in pansynovectomy.

The changes characteristic of chronic inflammation are found in the fat pads beneath the synovial lining. These normally project into the joint, though covered by synovial membrane and actually outside the synovial sac. They may be injured at the same time as the semilunar cartilage (indeed, an injured fat pad may be so congested and swollen as to simulate a dislocated semilunar cartilage), but the marked reactions in them, like those in the synovial membrane itself, are found in chronic and

FIG. 8C
Photograph showing knee six months after operation.

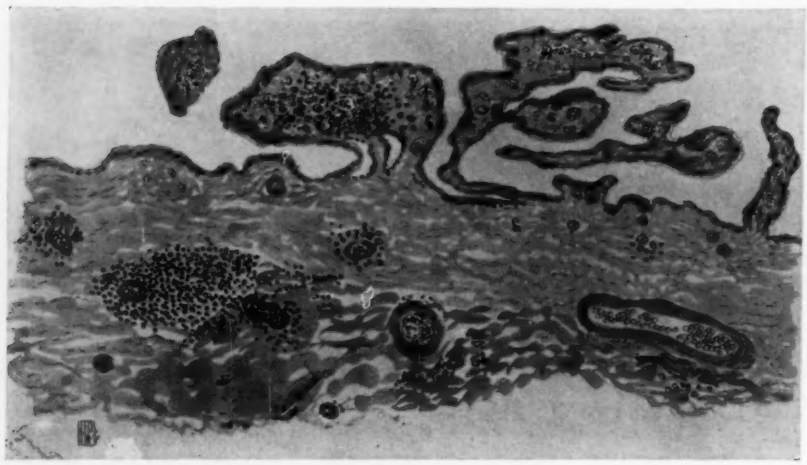

FIG. 9

Drawing of the microscopic findings in chronic synovitis accompanying dislocation of semilunar cartilage.

recurrent cases. Grossly, the fat pads show much congestion, thickening and induration. When sectioned they are red and hemorrhagic, but firm and solid, without the glistening quality of adipose tissue (Figs. 10 and 11). Microscopically, the fat tissue is found atrophic and compressed, as a result of marked fibrosis. The vessels are increased in number and thickness and many new capillaries are evident. The tissue often shows a degree of oedema. The inflammatory cell exudate is like that in the synovial membrane (Fig. 12).

Certain additional features are sometimes encountered. One of these is the development of a degenerative change in the newly formed vessels of the synovial membrane and fat pads (Figs. 13A and 13B). They show great narrowing of their lumina and a peculiar lamination of the wall, between the layers of which a bland material seems to have accumulated. Fisher has given the name "pericapillaritis diffusa" to this lesion and considers it very properly as an arteriosclerotic process. It is possibly comparable to the changes found in the placenta at term, and is an indication of involution in the vessels so affected. In a word, the reaction has reached a stage where these vessels are no longer needed.

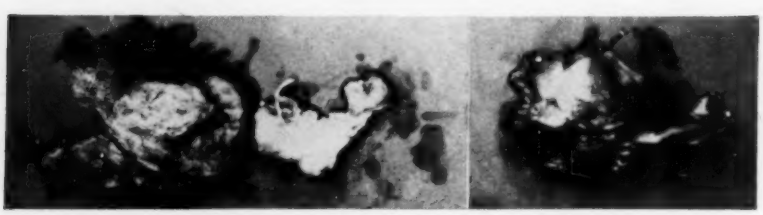

FIG. 10 FIG. 11

Chronic inflammation of fat pads about knee joint.

Another interesting and fairly common finding is the presence of much old blood pigment (hemosiderin), in granular form throughout the interstitial tissues of the hypertrophied synovial membrane (Figs. 14 and 15). Most of the granules lie within the cell bodies of endothelial phagocytes which are engaged in clearing up the remains of old hemorrhages into the synovial sac. But it is also commonly seen lying just beneath the surface, where it cannot always be shown to be intracellular. In places it seems to be associated with the mesothelial lining cells.

Long standing chronic inflammatory changes with hypertrophy and hyperplasia of the synovial fringes may lead eventually to further and extreme alterations. If, due to the vascular changes of involution, a bit of a fringe or villus becomes degenerated centrally, it may calcify, become detached, and form a foreign body. This

FIG. 12

Drawing of the microscopic findings in chronic inflammation and fibrosis of fat pad.

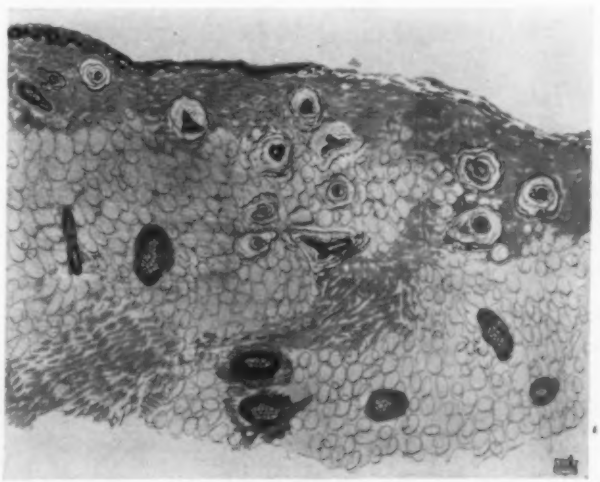

FIG. 13A

Drawing of the microscopic findings in pericapillaritis diffusa in synovial membrane, in a long standing dislocation of semilunar cartilage.

FIG. 13B

FIG. 14

FIG. 13B. Gross specimen of Figure 13A.
FIG. 14. Extensive pigmentation (blood pigment) in a chronic synovitis associated with a chronically dislocated semilunar cartilage.

again is attached to other villi, becomes covered with a cartilage-like layer, and we have a joint mouse. Or, at a certain stage, cartilage may form within a thickened and fibrosed villus by metaplasia of the connective tissue cells, and this may later separate off and go through the same process. Thus the formation of joint mice follows chronic aseptic inflammation of the synovial membrane.

In this discussion we have not included the factor of bacterial invasion, with all the changes leading to destruction, adhesions and stiff joints after injury. Nor is the development of the foreign body of the joint mouse or multiple chondroma type to be carried further than indicating its relation to chronic hyperplastic synovitis, associated with the result of a dislocated semilunar cartilage. The details described above cover the reaction within the joints in the cases we have studied.

## CAUSES OF INTERNAL DERANGEMENT

The exciting cause of internal derangement of the knee joint is usually some form of trauma, and the conditions produced vary from a simple sprain of the internal lateral ligament, to dislocation and fracture of a semilunar cartilage, rupture of the crucial ligament and lateral ligament, and fracture of the spine of the tibia.

Dislocation or fracture of an internal semilunar cartilage is the most common cause of derangement of the knee joint. The internal semilunar cartilage is intimately connected with the deepest layers of the internal ligament which is really a thickened portion of the capsule. The external semilunar cartilage is separated from the external lateral ligament by a pad of fat and the tendon of the popliteus. In the majority of individuals, in complete extension of the knee, there is no lateral motion or rotation of the knee joint. Lateral motion and rotation begin at fifteen degrees of flexion and increase as flexion increases.

*Mechanism of injury:* With a knee partially flexed and the foot fixed in an everted position, there is an external rotation of the head of the tibia on the femur. This opens up the joint and allows lateral motility. Force being applied, the internal lateral ligament carries the internal semilunar

cartilage with it, and as an attempt is made to straighten the leg, the cartilage is caught by the internal condyle of the femur rotating internally on the head of the tibia. The cartilage may slip back, or be split longitudinally or fractured.

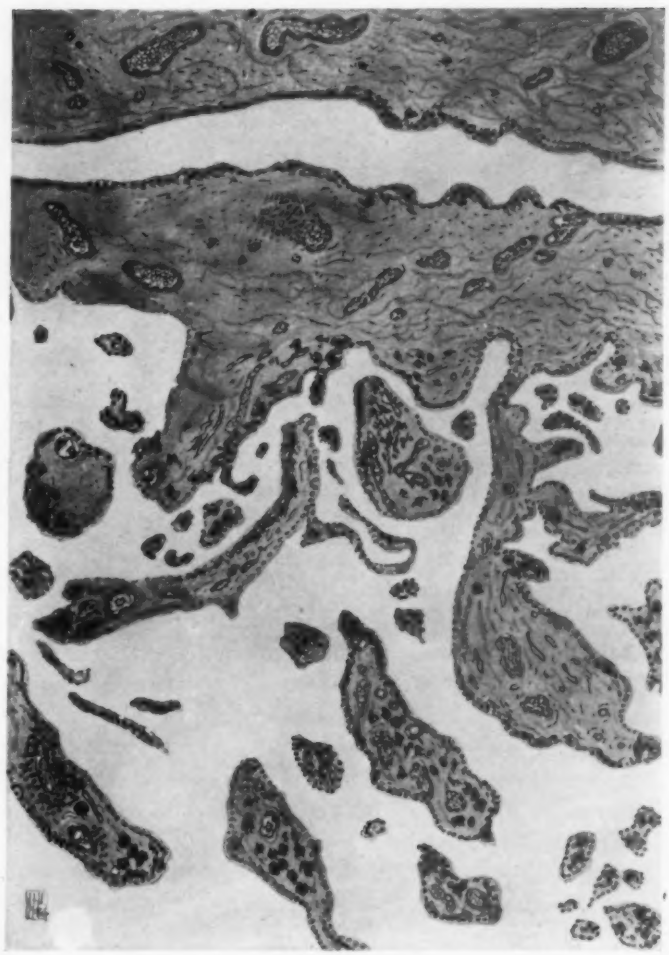

FIG. 15

Drawing of microscopic field from sections of the specimen shown in Figure 14. Extensive pigmentation.

In typical cases, the history and symptoms are as follows: a sudden severe strain with the knee in a flexed position, something slipping in the joint, usually severe pain, and immediate disability, the characteristic symptom being inability to completely extend the knee. The diagnosis is simple.

It is the recurrent and atypical cases that are important. In these cases the patient has only a vague idea of the injury. He feels something slip in the joint but there is no locking. The knee becomes distended with fluid. Examination will reveal a tender spot over the internal lateral ligament and over the anterior margin of the tibia just internal to the patellar tendon. Here there was an injury to cartilage without displacement, or if there has been displacement, it has slipped back into position. Under proper splinting and rest this will go to recovery without any further trouble.

The majority of these cases are not seen, and a series of slight traumata

FIG. 16

Tuberculosis with cyst of semilunar cartilage.

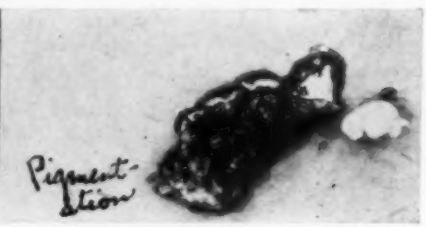


FIG. 17

Pigmentation and osteochondritis dissecans.

to the injured cartilage causes further effusion into the joint with subsequent stretching of the capsule and ligaments, atrophy of the muscles, and proliferation of the scar at the site of the healing of the torn cartilage. There results either a lengthening of the anterior end of the cartilage which loosens its attachments or, what usually happens—a mass of fibrous tissue is found underneath and anteriorly to the cartilage causing it to curl up and produce locking on any slight or unusual twist.

In atypical cases, the history often shows some severe wrench of the knee joint followed by effusion into the joint, laying the patient up for three or four weeks; the joint apparently recovers but there is always a complaint that the knee is weak. The patient has a sense of insecurity in the joint. Care has to be taken in walking; there is a sense of fear. The patient says that the knee never locks. Examination will show some swelling of the joint and points of tenderness over the internal condyle, external to the internal lateral ligament and over the inner anterior aspect of the joint. There is a slight limitation of complete extension (partial locking), so slight that a casual examination will miss it, but by a careful comparison with the other knee you will discover the slight limitation of extension present, and any attempt at further extension will cause pain and a rebounding or springing back of the joint into slight flexion. This is a very important point in the examination. The patient has a partial locking of the knee which he has not recognized and the knee has accommodated itself to this weakness.

FIG. 18

Fracture internal semilunar cartilage and fracture of spine of tibia.

In a majority of cases in which there has been a severe injury, the cartilage has not been completely restored to its normal position or, if in its normal position, a portion broken off or loosened either by hypertrophy or by

a mass of fibrous tissue caused by constant irritation during the process of repair.

A pad of fat subject to nipping loses its vitality and becomes infiltrated with lime salts. Under these circumstances the knee accommodates itself to weakness and is in a position of slight locking and hence unstable. A slight twist causes further locking or a recurrent synovitis.

From the anatomy and physiology above stated, given an injury to cartilage, the physiology of repair commences; according to Sir Robert Jones it takes a fortnight for blood vessels to grow into the site of injury of cartilage. He cites a very striking example:

"Colles' fracture produced by a fall on the palm of hand. There is immediate pain at the site of the fracture which overshadows any other injury to the upper extremity. The fracture is properly reduced and splinted, and immediately all pain has disappeared. In about two weeks' time, trouble begins, not at site of fracture but at the shoulder joint."

What is the inference? There has been an injury to the cartilage of the shoulder joint, but this injury to the cartilage has been of secondary importance to the Colles' fracture. It has taken nature two weeks' time to throw in blood vessels to repair the injury and now we have a site of acute inflammation in the process of repair. If the shoulder is properly put at rest repair goes on and we have a perfect functional result, with disappearance of pain. Unfortunately for the patient, too often resort is made to passive motion to prevent stiffness. What happens? A joint, the seat of acute inflammation is manipulated and the granulation tissue of repair is broken up and nature has to start all over again. Another

FIG. 19
Osteochondromatosis.

unfortunate example is the treatment given to our high school or college athlete. He sustains an injury to the joint; under treatment pain and swelling subside, and repair is going on. The joint feels fairly well; in a week, or at the most, by the end of two weeks, he is rushed into play and at about the first play, he is tackled and goes down and is carried off the field. Here again is an example of motion at the time of acute inflammation of the joint.

So in the recurrent cases of dislocation of the semilunar cartilage, nature is sending in blood vessels to produce physiologic repair and they are constantly being broken up and thus there begins a pathological inflammation and destruction of the joint. At operation of cases of old and recurrent dislocations of the semilunar cartilage we find:

First: the gushing out of quantities of fluid of various colors and consistence; serous, yellow, straw, grayish brown, to bloody.

Second: in ninety-eight per cent. of cases, in practically all except those operated on during first week, pannus formation over margin of cartilage, the intercondyllar notch, internal to the spine of tibia, around the under surface of patellar ligament and around the semilunars in long-standing cases. These pannuses vary in extent and thickness; are always present; at times are developed out of all proportions to the clinical signs and findings.

Third: enlargement, oedema and hemorrhagic infiltration of the infrapatellar fat pad. At times the infrapatellar fat pad had so hypertrophied that one marvels that so much fat can be contained in a knee joint.

Fourth: thickening of the synovial membrane by fibrosis with calcification in long standing cases.

Fifth: the cartilage is rolled up in the front of the joint, surrounded and fastened to front of capsule by a mass of fibrous tissue.

Sixth: in very long continued cases, underneath the heavy pannus

FIG. 20
Osteochondromatosis.

formation, the surface of the cartilage is eroded and even completely destroyed.

Seventh: a thickening and contracture of the ligaments and especially the posterior capsule which renders a perfect result impossible.

## ANALYSIS OF SYMPTOMS

1. *History of injury:* In eight out of seventy-one cases, or eleven per cent. of the cases, there was absolutely no history of injury, while in a small percentage there was only a vague history, leaving eighty-nine per cent. of cases attributing the cause of their trouble to a distinct injury.

2. *Pain and tenderness:* Pain was mentioned in seventy out of seventy-one cases, almost one hundred per cent. of cases. There are several common sites of pain. These are: (1) over the lateral ligament at the edge of the articular cartilage; (2) over the anterior edge of the cartilage, internal to the spine of the tibia; (3) to either side of the patellar ligament; and (4) along the line of articulation posteriorly.

Tenderness was elicited at these points. Why are these sites tender? A study of anatomy, physiology and pathology indicates that these are the sites of pannus and fibrous tissue formation. The synovial membrane which covers these sites is rich in minute nerves; these are subject to pressure from inflammatory products and are in a state of irritation. Hence, pressure being applied, tenderness is elicited and pain produced. This is important to know in reference to prognosis and treatment. For example, after a joint is put to rest and all symptoms relieved, even lack of extension, if at these points tenderness persists, it tends to show that the pathologic process is going on, and all is not well within the joint.

3. *Swelling,* was present in all but five cases, about ninety-three per cent. of cases. This swelling was either evidenced by thickening of tissue or fluid.

4. *Weakness:* Present in about ninety per cent. of cases. By this is meant fear in using the joint or unstableness in walking over rough ground.

5. *Locking:* History of locking as related by patient was present in fifty-three of seventy-one cases, or about seventy-five per cent. of the cases.

6. *Lack of complete extension:* Was present in almost one hundred per cent. of the cases. One case out of seventy-one did not have loss of complete extension, which means that almost every case had a joint in a position which had accommodated itself to a slight flexion or locking and that twenty per cent. of the seventy-one patients did not know that the knee was in state of partial locking. This is important to know, because in text-books, locking is given as a prominent symptom of dislocation of the internal semilunar cartilage and if the patient denies the locking, the physician is apt to be misled. What causes a joint to lock? The space between the actual bearing surface of the condyles of the femur and the

tuberosities of the tibia is practically nil. For instance, in operating on a joint in a flexed position, if one thickness of gauze is placed between the condyle and the tuberosity it will be impossible to fully extend the knee. Hence one can easily see that a slight displacement or a hypertrophy of a semilunar cartilage or fat pad and the usual fibrous tissue formation would produce mechanical locking.

This also points out how perfect a closed reduction of a dislocated or fractured cartilage must be in order to get a good result by closed reduction.

### X-RAY FINDINGS

X-ray pictures are usually negative, except that possibly they may show a narrowing of the space on the side of the offending cartilage and a thickening of the structures in the anterior pouch. A number of times they have shown a lipping and osteo-arthritis at the margin of the condyles; at operation these conditions are not found, but the picture is due to a thickened pannus and atrophy at margin of the cartilage and a dissecting away of the lateral ligaments from their attachments by chronic inflammatory products.

### DIAGNOSIS

Limitation of extension is the most important symptom in the diagnosis of internal derangement of the knee joint. Without it a diagnosis should never be made, except where after complete rest to the joint, tender spots over the site of pannus formation persist, when an arthrotomy should be done. Given a history of weakness and instability of the joint without the accompanying pain and every other physical sign absent, except limitation of the extension, be that limitation ever so slight, one is justified in making a diagnosis. It has been practically impossible to differentiate between derangement of the knee joint caused by a loose cartilage and one caused by nipping of the pad of fat. In some cases the two conditions were present and in other cases pedunculated pads of fat were found on operation where a previous diagnosis of loose cartilage had been made. Sprain of lateral ligament is indicated by pain and tenderness over the lateral ligament, but no loss of extension.

External semilunar cartilages are not nearly as common as dislocated internal semilunar cartilage, and after removal of external semilunar cartilage, as a rule, the time taken to cause improvement has been long. In these cases there have been symptoms which would seem to indicate that there has been some injury to the internal semilunar cartilage at the time and it is logical to believe that an injury which causes dislocation of the external semilunar cartilage must have been severe enough to also cause trouble at the internal semilunar cartilage which is very easily injured.

In two or three cases of injury to the external semilunar cartilage in which the external semilunar cartilage has been removed, it seems almost certain that if the internal semilunar cartilage had been removed at the

same time, the joint would have been improved. If the condition of the patient allows, it is wise to at least investigate the condition of the internal semilunar cartilage at operation.

There have been seventy-one arthrotomies performed in which sixty-three internal semilunar cartilages were removed, and eight external semilunar cartilages. In three cases fat pads have caused the trouble and in one of these cases the cartilage had entirely disappeared. In three cases both internal and external semilunar cartilages were removed. In three cases, in the operation for removal of semilunar cartilage it was discovered that there had been a tuberculous condition of the joint involving the semilunar cartilage. One case was a tuberculous cyst, springing from the anterior end of the semilunar cartilage. In one case where a synovectomy was done for the removal of a pansynovitis of the joint it was found that the original trouble had been a rupture of the posterior horn of the internal semilunar cartilage with the fastening of the fragment above the internal condyle.

In sixty-eight out of seventy-two cases of chronic malfunction of the knee joint, mechanical factors were the underlying cause. In only three cases was there an infectious origin.

## OPERATION

The operation consisted in flexing the knee over the end of the table and a straight incision internal to the patella for internal semilunar cartilage and external to the patella tendon for external semilunar cartilage. If more room was needed the incision was extended up and curved in around the top of the patella separating the fibres of the quadriceps muscle. In this way the patella could be dislocated to the outside of the joint and a free exposure of the joint obtained. This straight incision absolutely interferes with no structures and there is no strain on the incision afterwards. The cross incision through the lateral ligament in the removal of the internal semilunar cartilage always leaves a weakness at the site of the scar.

There have been only three slight skin infections in the cases that were of mechanical origin, and these healed up in a very few days with application of wet dressings. Of course, the incision has always been made with towels clamped to the edge of the wound and the utmost precaution has been taken. The operation on the knee joint, therefore, is not the fearful procedure it once was thought to be.

Herewith are presented the details of four cases which illustrate the different types of cases described.

CASE 1. *Typical case of recurrent dislocation of internal semilunar cartilage.* John N. F., aged twenty-three, single, car repairman, helper. Examined March 9, 1923.

*History.* On January 14, 1923, car coupler fell, striking him on the outer side of right knee cap; knocked knee inward with foot twisted. Knee cap was dislocated inward. Patient says knee was flexed and as he made an effort to straighten it, he felt something snap and leg straightened. Had application of iodin and bandage. Next

day leg began to swell; remained swollen and painful. He used crutches for a week, went to a private hospital and had epsom salts, wet dressings for a week and a half, then went home, feeling fine. The following day in getting out of bed, knee again locked. He pushed it and felt something slip. Then he had violet-ray treatment. Knee has locked several times since.

*Examination* shows right knee swollen both above and below on both sides of patella. Limitation of complete extension. Flexion is good, but patient complains of pain over internal semilunar cartilage when moved. Tender over anterior end of internal semilunar cartilage.

*X-Ray.* Negative.

*Diagnosis.* Dislocation and tear of internal cartilage.

*Operation*, March 28, under gas anaesthesia, straight incision, internal and parallel to patellar tendon, extending to below margin of tibia. Internal semilunar cartilage torn and dislocated anteriorly, lying in front of joint. The rupture was at the internal border of cartilage at its insertion into the capsule at the internal lateral ligament. There was a mass of fibrous tissue which was richly injected. The synovial fringe and fat were injected and oedematous. There was a pannus growing down over the internal condyle. About an ounce of straw-colored fluid escaped on opening of capsule.

CASE 2. *A typical recurrent dislocation of joint.* Miss E. S., referred by her brother, Dr. S. Examined March 9, 1922.

*History.* Ten years before while in surf at Atlantic City, had left knee twisted. It became very much swollen and painful and she was in bed for two days. About December 1, 1921, left knee began to pain and swell. Got better after a couple of weeks. For the last couple of weeks before examination, knee had become worse, was swollen and she had difficulty in walking on it. Patient said that knee never locks, as rule does not hurt her at night, but sometimes keeps her awake. Bothers her going up and down stairs. Hurts her on both sides of patella, worse on inside.

*Examination* showed a tender area over the internal semilunar cartilage and a moderate degree of limitation of extension. There were no other symptoms or physical signs. A diagnosis was made of dislocation and tear of internal semilunar cartilage, and an operation was advised in spite of lack of other physical signs.

*Operation*, March 29, 1922, under gas anaesthesia, straight incision. Pannus was found growing down over inner condyle of femur. There was a large tab of injected fat with one end loose in the joint. The internal semilunar cartilage was much frayed and loose on its anterior margin. The pannus was removed as was the tab of fat and the internal semilunar cartilage. A large compression bandage was applied. She went home and in four weeks from time of operation she wrote, "I am very much delighted that I can walk around without any pain or limping".

CASE 3. *Nipping of a tab of fat, which simulated dislocation of external semilunar cartilage.* Wm. B., aged twenty years, Mercy Hospital, January 14, 1922. Night before was playing basket ball; while in the air jumping for the ball he felt his left knee lock and he came down on other leg. Knee was very painful and swollen and he was unable to straighten it. On examination, left knee was locked in about forty-five degrees of flexion and was so painful that he would not permit it to be moved. The knee was prepared for operation and on January 16, 1922, under gas anaesthesia a reduction was attempted, and on manipulation of knee a mass about the size of a small chestnut protruded from the anterior aspect of the joint internal to the external lateral ligament. This mass was hard and crepitated. It disappeared under direct pressure. An incision was made just internal to the lateral ligament and when the capsule was opened there was an outpouring of straw-colored fluid, and a mass of very dark, almost macerated, fat was extruded from the joint. This mass had been pinched and became devitalized. It was removed along with a large piece of fat at its base. The external semilunar cartilage was intact and not touched. He made an uneventful recovery. The diagnosis before the operation had been a ruptured and torn external semilunar cartilage.

CASE 4. *Recurrent dislocation in which symptoms were not always present.* Mr. S. P. B., aged thirty-three. Seen July 27, 1922.

*History.* Two months ago took an automobile trip and after returning felt stiff and sore all over. Symptoms all disappeared except in right knee. Now complains of pain and stiffness on arising and using it. First few steps are painful, also painful if he flexes knee beyond right angle. This knee was injured on several occasions. First time, twenty years ago while riding a bicycle; also hurt it while playing football.

*Examination.* No swelling or redness of knee, tender spot on the internal condyle of femur. No tenderness over semilunar cartilage. No loss of extension. Walks in ankle valgus. He was strapped, and also shoes were raised on inside. Was not seen for five months. Same treatment was continued. Strapping for two months. Patient said that after unusual walking or playing eighteen holes of golf his knee swelled and got stiff. On April 4, 1923, he appeared after a long walking trip. Examination showed right knee swollen. He cannot extend leg. Cartilage can be palpated on inner anterior aspect of joint on flexing the knee.

*Diagnosis.* Dislocation of internal semilunar cartilage. Operation was advised.

*Operation*, April 9, 1923, under gas anaesthesia, straight incision. There was a large pad of fat outside of capsule. On opening capsule there was a gush of straw-colored fluid. The cartilage was lying loose in joint. There was a large pannus growing down over internal condyle, with erosion of the cartilage of condyle near the attachment of the internal semilunar cartilage. The infrapatellar fat pad was removed.

## CONCLUSIONS

1. Tender areas at site of pannus formation are signs of trouble within the joint.

2. Lack of complete extension is the most important sign in internal derangement of the knee joint.

3. Many patients have knee joints which have accommodated themselves to weakness and are in a position of slight locking all the time, as evidenced by lack of complete extension.

4. A misplaced or hypertrophied semilunar cartilage or fat pad is a foreign body which acts as an irritant, which will produce a vicious pathologic cycle leading to destruction of the joint.

5. Careful and repeated examination is necessary in making a diagnosis of internal derangement of knee joint.

6. Removal of the offending objects is the surest way to effect a cure.

## BIBLIOGRAPHY

1. GRAY, HENRY: Anatomy; Descriptive and Applied. Ed. 18, Philadelphia, Lea & Febiger, 1910.
2. KEY, J. A.: The Reformation of Synovial Membrane in the Knees of Rabbits after Synovectomy. J. Bone and Joint Surg., VII, 793, Oct. 1925.
3. LEWIS, F. T. AND STÖHR, PHILIPP: A Textbook of Histology. Ed. 2, Philadelphia, P. Blakiston's Son & Co., 1913.
4. SCHÄFER, E. S.: The Essentials of Histology. Ed. 11, Philadelphia, Lea & Febiger, 1920.
5. FERGUSON, J. S.: Normal Histology and Microscopical Anatomy. New York, D. Appleton & Co., 1905.
6. FISHER, A. G. TIMBRELL: A Contribution to the Pathology and Etiology of Osteo-

arthritis; With Observations upon the Principles Underlying its Surgical Treatment. Brit. J. Surg., X, 52, 1922.

7. Fisher, A. G. Timbrell: Some Researches into the Physiological Principles Underlying the Treatment of Injuries and Diseases of the Articulations. Lancet, II, 541, 1923.
8. Jones, H. T.: Loose Body Formation in Synovial Osteochondromatosis, with Special Reference to the Etiology and Pathology. J. Bone and Joint Surg., VI, 407, Apr. 1924.

## DISCUSSION

Dr. Mark H. Rogers, Boston, Mass.: I had a chance to read this paper in its entirety and I think the part of this paper that we will enjoy and keep for record is the anatomical and pathological study. The pathological work seems to be very complete and I think in his reported cases the percentage of internal and external dislocations of the knee joint are about the same as Sir Robert Jones, ten or five per cent. Another point that I am a little surprised about is, that of the seventy-five cases of internal derangement of the knee joint, there was such a large percentage of internal cartilage cases and not of the other lesions causing internal derangement. Without being able to state figures, I would say that osteochondritis dissecans very often simulates cartilage disease. I know personally that I have several times gone into the knee joint, thinking I would remove a cartilage, and found osteochondritis dissecans. I supposed it was much more common than this series would indicate. Dr. Wallace did not bring it out in his talk, but in his paper is the statement that loose bodies are probably formed from debris from the cartilage, and I suppose he means from the semilunar cartilage. I am not sure that that is the correct pathology.

Dr. Wallace: The debris from the synovial membrane.

Dr. Rogers: I am personally a little doubtful about that pathology, though I cannot state exactly what the pathology is. I think that may be questioned later. Personally, on the whole, I like this paper. It is a very complete record and will probably go into our literature for future reference.

Dr. J. Torrance Rugh, Philadelphia, Pa.: I was very much interested in this series of cases which Dr. Wallace reported. I think it is an extremely timely and practical paper. I have always been impressed with the importance of the fat pad in the knee joint so far as internal derangements are concerned. Experience has shown that careful investigation of this structure gives all degrees of infiltration, and I have found that it is usually the repeated injuries of ordinary every-day life which tend to bring about the fibrosis in the fat pad and the ultimate interference with the function of the joint. I do not see many cases of fracture or dislocation of the semilunar. I see a great many cases of pannus.

There is another interesting clinical observation. One rarely opens the knee joint of an active individual but he finds evidence of pannus. In many instances it is absolutely painless and is a simple thickening of the synovial membrane. I happen to have a pair of such joints myself that I have known of for thirty-eight years. Under what conditions this pannus becomes painful, I have not been able to determine. It is true, as brought out by Dr. Wallace in his paper, that this hyperplasia occurs in the folds of the synovial membrane and over the sides of the joint. Those are frequently more painful than any other portion, as he brought out.

The most important point of the paper to me is the plea for early operation in these cases, and the removal of the offending material. I want to express my appreciation of the paper.

Dr. Robert B. Cofield, Cincinnati, Ohio: I had the pleasure of reading this interesting and instructive paper coming over on the train, and as one of the other gentlemen expressed it, I feel that you will not appreciate this paper from what Dr. Wallace read to you, as you will in getting the complete edition.

It seems to me that most of us have neglected or at least have been disappointed in not finding pannus in many of these cases simply because we have not looked far enough

for it. There is no doubt but we all see it occasionally. Continuing the incision upward along the inner side of the patella sufficiently to explore the knee joint, is very necessary unless we are thoroughly convinced that rupture of the cartilage is the only offending mechanical obstruction. By so doing we will be more apt to discover pannus and other lesions of the knee joint. It seems to me that the symptom of pain on pressure over the pannus would not necessarily mean that the lesion was confined to an injury of the cartilage. We might have a number of other derangements of the knee joint which would produce the same pain on pressure, and I think Dr. Wallace brought that out in his paper more clearly than he did in the portion that was read.

I think we all appreciate the successful results that we have in these cases, due to careful surgery with ordinary care in the after-treatment. I certainly appreciate hearing Dr. Wallace's paper.

Dr. Samuel Kleinberg, New York, N. Y.: I would like to speak about the injection of oxygen into the knee joint, a procedure which gives us an insight of where the pathology is located. I recall several instances in which, after injecting oxygen into the knee joint, I was able to determine exactly where the pathology was located. In a number of cases the inflammation was located in the quadriceps bursa. In another instance it was found in the popliteal bursa. I think the procedure is very valuable.

Dr. F. H. Albee, New York, N.Y.: I have been impressed with the complicated conditions which may be coincident with the derangement of the internal semilunar cartilage. By this I mean injury to the crucial ligaments, and fragments of cartilage, with or without bone, that may be broken away from various parts of the joint, resulting in joint mice. It is apparent that, in order to get complete relief, treatment of all these conditions must be accomplished. I notice that Dr. Wallace left out the question of the approach to the knee joint, which is very important in respect to the complications. The lateral incision does not begin to allow for complete exploration of the knee joint, and consequently, in operating upon lacerations of the semilunar cartilage, such complicated conditions are frequently overlooked. Therefore, soon after Sir Robert Jones recommended his split patellar approach to the knee, I began employing this in all of these cases, and have been surprised at the frequency with which I have found complicated conditions which demanded relief at the same time as the lacerated cartilage.

I have been unable to determine that the split patellar approach delays convalescence in any way, and have not in a single case had any untoward result from the split patella. I have, therefore, not used the long incision beside the patella which some have employed in recent years.

Dr. Charles Ogilvy, New York, N. Y.: There are two or three things that stand out mechanically when we treat these cases. In the first place is the difficulty of making an accurate diagnosis. We can never tell what we are going to find in going into a joint. The injuries to the semilunar cartilage are very numerous. Sometimes we go in to remove the semilunar cartilage and find other conditions that we did not expect and that necessitate wide incisions. To return to the old cases that have been going on for years, the cases Dr. Wallace had in mind,—another important fact is the remarkably good results that we obtain. We cannot speak of one hundred per cent. cures, but we do get a very marked improvement in a large majority of the cases. We see patients who have gone on for months and years, who have decided improvement, and some of them cures. Another thing I would like to emphasize is the necessity of early motion. In the majority of the cases, we are able to have the patient up and about in five weeks after operation.

Dr. M. S. Henderson, Rochester, Minn.: Derangements of the knee joint are not always easy to diagnose. The pain following the accident and the suddenness with which it occurs make it difficult for the patient to accurately describe the conditions at the time of the accident and the manner in which the injury was received. In the chronic cases in which the chief symptoms are a feeling of instability and the inability to completely extend the knee, we have found the pathology to be very often the bucket-handle type of injury described by Rutherford Morrison.

We hear conflicting opinions expressed by men with considerable experience in this line of work; some say that the semilunar cartilage should only be removed when a definite tear is found, and others think that it should be removed if the subjective symptoms are definite. While on a recent visit to England I questioned some of the surgeons I saw about this, and it seemed to be the somewhat universal opinion that it is best to remove the cartilage when the subjective symptoms are clear cut, on account of the fact that quite often the pathology will be found in the posterior part of the cartilage where it cannot be seen until the cartilage is out.

Dr. Robert B. Osgood, Boston, Mass.: I have nothing to say except to thank Dr. Wallace for his paper. We have been using the longitudinal J-shaped incision for fifteen years. I feel very strongly in some cases that it is difficult to explore the joint sufficiently by a short, horizontal incision. I have begun to feel that the exploration should not be made through a mid-patellar incision. I have followed many of these mid-patellar incisions and have found in after years that the patella enlarges and its articular surface is not smooth. It is possible to get just as good an exposure of the whole joint through a parapatella incision. I agree with Dr. Albee that thorough exposure is often necessary by some incision of this sort.

One thing in relation to Dr. Rogers' remarks, though I know it is not proper to discuss a discussion, I would say that in a large series of internal derangements published some years ago by Dr. Surls and myself, we found almost the same proportion of internal derangements due to semilunar cartilage lesions that Dr. Wallace found.

Dr. A. H. Cilley, New York, N. Y.: I think we ought not to wait forever until we have made a diagnosis, but we ought to go into these joints and clean them up much earlier than some of us have been doing. I know personally I have waited and waited and strapped them and plastered them and done everything else, and I am going to begin now to go after them much earlier and I believe that the results will be much better.

Dr. G. E. Bennett, Baltimore, Md.: I was rather surprised in this large series of internal derangements that the crucial ligaments were not mentioned. It has been my experience that the crucial ligament injuries are more common. There are many cases diagnosed as loose cartilages, which are really cases of crucial ligament injuries, as they produce similar symptoms.

Dr. E. A. Rich, Tacoma, Wash.: I am led to inquire whether it is not possible that the types of knee injuries in orthopaedic practices vary greatly in our country with the geographic location of the surgeon. Does it not seem likely that an observer in the Pacific Northwest, in the midst of extensive lumbering industries, would be presented with quite different types from those presented in an agricultural section? In our country we see severe traumata of the knee, resulting in capsular tears and avulsions and all manner of mutilations, but with few ruptures of the crucial ligaments. This leads me to ask Dr. Wallace just how frequently he finds these crucial ligament tears and how much importance he places upon such accidents. I would like to ask further whether he believes that in adult knees the integrity of these crucial ligaments is vital for stability.

Dr. F. J. Gaenslen, Milwaukee, Wis.: I would like to ask Dr. Wallace whether by derangements of the knee joint he means, as most of us do, injuries or dislocations of the semilunar cartilages. The demonstration of a pannus in a large proportion of cases of derangements, as shown in the illustrations of Dr. Wallace, impresses me very greatly. In a fairly large number of patients operated on for internal derangement, I have not seen the pannus which Dr. Wallace describes, at least not in cases uncomplicated by chronic infection or hypertrophic arthritis. To me pannus means infection, and I should like to ask Dr. Wallace to tell us something more about the production of it in the uncomplicated cases of internal derangement.

In two cases which Dr. Wallace showed, I believe the ages were given as sixty-three and sixty-eight, in both of whom osteoarthritic changes may have been present to account for the pannus. Perhaps a larger incision, as advised by Dr. Wallace, affording greater opportunity for study of the joint margins, will show the lesion in question more often.

DR. LEO MAYER, New York, N. Y.: I did not understand what Dr. Wallace said he does with pannus. After incisions, does Dr. Wallace ligate all the vessels which show up so perfectly? Second, in removing the fat pad, does he attempt to ligate the vessels which are under the fat pad?

DR. JAMES O. WALLACE, Pittsburgh, Pa.: (Closing the discussion): This paper has really been limited to cartilage derangements and fat pads in order to not complicate it and to better work up our pathology.

Answering Dr. Rogers, I simply showed that case of osteochondritis dissecans to make out a full picture. I have seen a great many more of them, but I did not put them in as a complete series and so gave no percentage deduction.

In reply to Dr. Bennett's question about rupture of the crucial ligaments, I think they are comparatively rare. I have seen about a half dozen, but I have not brought them out in this paper.

As far as the incision is concerned, I use a straight incision, no curves of any description. If you remember the picture in which I took out the whole suprapatellar bursa above the condyles, I did that through a right suprapatellar incision, going around the patella and splitting the fibres of the quadriceps. With that incision I was able to dislocate the patella external to the joint. I could see everything in every portion of the joint and for that reason I think a split patellar incision is absolutely unnecessary. There is just one danger. In the hands of you men there is no danger in taking that right handed curve in your incision, but unfortunately many men do not seem to know that you should not cut the lateral ligament crosswise. I see many cases in which the general surgeons have used the cross incision in taking out a semilunar cartilage and have cut through the lateral ligament, with a resulting weak joint.

As far as the oxygen treatment is concerned, I have not used it. I think it is a good thing where you are interested in the finer points of diagnosis. Paying attention to the point of tenderness, you can go in on either side of the joint and it is not necessary to have any extra means of making a diagnosis. The incision that I make for most of the cases is an incision two inches long, parallel to the patellar tendon. I can take out the cartilage through that incision, dissect the cartilage away from the lateral ligament and cut off the posterior attachment. A friend of mine brought over an instrument from Germany like a guillotine, in which you can go in and cut the cartilage through, then thread the cartilage through a slot back to the posterior attachment and cut it off. Personally I have not tried it.

Dr. Henderson spoke about the bucket-handle type of injury. One of my patients was a man with a similar injury, in which the cartilage went over into the intracondylar space, and for a time when he walked or did ordinary work it never bothered him, but if he played golf or walked over a rough road, it always caught him.

I always do these operations under an Esmarch. With that incision if you go high enough up you will find the pannus formation in all of them. In that boy of fourteen years, with an injury two years before, the whole top of the femur was covered with vegetative material at least one-eighth inch thick. In taking out the fat pad and the pannus, if the pannus is too thick, I simply wipe it off with gauze or dissect it away. The ordinary pannus I pay no attention to. As for the after-treatment, I put these knees up in compression dressings right away. We have, of course, the vessels blocked off and those that are tied. I leave them up for two weeks before I allow the patients on their feet. For a while I had a series of cases in which I let them up on the third day.

I had a foreigner come in with a definite injury and I told him he would have to have the cartilage removed. He was afraid if he were operated on he might have a stiff knee so he said, "Nothing doing". About three weeks later he fell on the ice and was down for twenty minutes and could not get up; so he came in to have the cartilage removed. All the time we were closing the incision he was flexing and extending the knee, and there was no tension. He was up on the third day. I did that on a number of cases until I saw Sir Robert Jones, who told me that two weeks was the proper time. Since then I have been taking his advice.

# TUBERCULOSIS OF THE KNEE JOINT IN THE ADULT*

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Other things being equal, it is generally conceded that tuberculosis of the knee joint in the adult patient warrants resection. A good result so rarely follows conservative treatment in such cases, and so much time is consumed, that when the facts are squarely put before patients, most of them will select resection. We are reporting here 211 cases of tuberculosis of the knee joint in the adult treated by resection in the Mayo Clinic from 1913 to 1926 inclusive. The diagnosis in each case was proved either by microscopic examination, guinea-pig inoculation, or both. Definite information as to the end results has been obtained in 194 cases.

## ETIOLOGY

Of the 211 patients 140 (66.3 per cent.) were males, and seventy-one (33.7 per cent.) were females. The average age of the male patients was twenty-nine and one-half years; of the female patients twenty-eight and one-half years. Twenty-four patients (10.8 per cent.) were in the second decade (11 to 20 years), ninety-one (42.78 per cent.) were in the third decade (21 to 30 years), sixty-seven (31.49 per cent.) were in the fourth decade (31 to 40 years), twenty-two (10.34 per cent.) were in the fifth decade (41 to 50 years), and seven (3.29 per cent.) were in the sixth decade (51 to 60 years). The fact that seventy-four per cent. of the patients were between the ages of twenty and forty indicates that the disease at this productive period in life so inconveniences the patient that he seeks relief through surgery. The onset of the disease occurred between the ages of ten and thirty years in sixty-four per cent. of patients.

In spite of an increase in the total number of patients taken care of in the Section on Orthopaedic Surgery of the Clinic, the number afflicted with tuberculous knee joints is less than it was a decade ago. This is the experience also of other orthopaedic surgeons in the United States and we believe that the decrease can be attributed to the better understanding of tuberculosis by the people, and to the extensive pasteurization of milk and the inspection of the dairy herds.

It must be borne in mind that tuberculosis of the knee joint is a blood-borne disease, always secondary to a focus elsewhere in the body. It is, therefore, imperative that patients with this disease shall be thoroughly examined and a search made for other tuberculous foci. All of the

*Read before the American Orthopaedic Association, Yosemite Valley, California, June, 1927.

patients in this series were examined thoroughly, including, in all but a few instances, roentgen-ray examination of the chest. The lungs of sixty-one patients were affected and thirty-seven were afflicted with various lesions other than that in the knee.* Of the sixty-one patients whose lungs were involved thirty-seven had active tuberculosis, twenty-two healed tuberculous lesions, and two markedly calcified glands. Thus, there were ninety-eight patients (43 per cent.) in whom we were able to demonstrate tuberculous foci elsewhere than in the knee. Furthermore, five patients on whom we operated returned later with lesions elsewhere. This emphasizes the necessity of giving attention to the general condition of any patient with tuberculosis of a joint and providing for adequate systemic treatment. It is difficult to determine the exact site of the primary focus but usually it is in the mediastinal or mesenteric lymph nodes.

*Family history.* A history of tuberculosis in the family was obtained in only nine and forty-three one-hundredths per cent. of the cases.

*Trauma.* Trauma as a factor in the development of tuberculosis is worthy of consideration. The knee, particularly in the young patient, is subject to repeated trauma and therefore all patients were questioned regarding previous injury. We were able to elicit a history of injury to the affected knee in 110 cases (51.8 per cent.), but the average time from the stated injury to the development of symptoms was eleven and three-tenths years. In these cases, therefore, the effect of trauma on the development of tuberculosis in the knee years later is questionable. However we were able to associate a history of injury that seemed to have to do with the development of the lesion in twenty-eight cases (13 per cent.).

*Association of tuberculosis with acute diseases.* In twenty-three cases we found a reasonable connection between acute illness, such as influenza, measles and acute pleurisy, and the development of tuberculosis of the knee. It was only in a small number, however, that joint manifestations were so closely allied to the illness that the relationship was definite.

## SYMPTOMS AND DIAGNOSIS

In 175 cases (82.54 per cent.) the onset of the disease was gradual. The outstanding subjective symptoms of tuberculosis of the knee joint are stiffness and pain, while the objective symptoms are local heat, deformity, and limp. More than ninety-nine per cent. of our patients complained of pain, one hundred per cent. complained of stiffness; ninety-nine per cent. of limp, ninety-seven per cent. of swelling of the knee, and 113 patients (53 per cent.) of local heat, as noted on the records. The disease is characterized by chronicity and remissions, and there is never complete freedom from symptoms. The patient may state that he has periods of freedom, but on close questioning it will be found that a limp and some stiffness, which is usually most noticeable in the morning, have persisted, but may

*In twenty-eight of these thirty-seven, roentgenograms of the chest were negative, in four the roentgenograms showed old, healed tuberculous lesions, and in five active pulmonary tuberculosis.

wear away on use. The more observing of the patients also admit that there is usually some swelling present, even during remissions. The pain in cases of joint destruction was characterized by being worse on jarring and jolting, caused by walking on uneven ground, stubbing the toe, and so forth. It may entirely disappear for a period, but there is always some residual stiffness and soreness on use. The degree of pain depends largely on the amount of destruction in the joint and may vary from excruciating and unbearable pain associated with typical night jerks to merely mild aching. The thickening was characterized as periarticular in ninety-three per cent. of the cases. In ten per cent. of cases night sweats occurred, in thirty per cent. fever, and in thirty-three per cent. weight had been lost, the average loss being fourteen pounds. In more than ninety-six per cent. of the cases atrophy of the thigh and calf occurred and in seventy-two per cent. slight flexion deformity. In more than eighty per cent. tenderness, generally localized on the inner side of the knee, was complained of, and in forty-six per cent. patients were so disabled that they were using crutches when they came for examination.

A positive clinical diagnosis of tuberculosis was made from the history and objective data in more than ninety per cent. of the cases, although a positive diagnosis of tuberculosis had been made previously in only seventeen per cent. The roentgenograms in practically all of these cases were positive, usually some degree of destruction of the surface of the joint being shown. We do not believe there is a typical roentgen-ray picture of tuberculosis of the knee. The roentgenogram shows only the shadows cast by the structures and these vary. In the acute boggy knee the fluid and oedematous tissues cause a haziness of outline and lack of bony detail. In the chronic cases the bony detail is more marked and the destructive process more apparent. Lipping and attempts at repair may be noted also. The roentgenogram is an aid in diagnosis but cannot be depended on to any great extent in the differential diagnosis. We resorted to aspiration and the guinea-pig-inoculation test in the doubtful cases. Positive results are a valuable aid in the diagnosis; however, negative results are a comfort in certain cases.

Early diagnosis is essential. If diagnosis is delayed until the lesion is so self-evident that abscesses and perhaps sinuses have formed with the customary secondary pyogenic infection, the danger of resection is greatly increased.

## PATHOLOGY

The ever-present question with regard to the pathology in cases of tuberculosis of the knee joint is whether the disease was primary in the synovia or in the bone. This question cannot be answered in the individual case for usually the disease is so advanced in the cases coming to resection that both the synovia and the bone are involved. Our records show that in twenty-one cases (9.87 per cent.) the bone was not involved and, therefore, we concluded that the synovia was the primary site. When abscesses

of the bone were present they were usually either in the internal condyle of the femur, or the inner tuberosity of the tibia. This is of interest because most of the tenderness complained of was on the inner side of the knee. Involvement of the patella was noted in ten cases. The degree of "wetness" and the amount of destruction, and so forth, did not appear to be a criterion as to whether or not bony union would result after resection. We are forced to conclude that much depends on the thoroughness of the operation and the care with which accurate bony contact is obtained and held.

## DIFFERENTIAL DIAGNOSIS

*Chronic infectious arthritis.* Tuberculosis is more common in young patients whereas infectious arthritis is more common in elderly patients. In the infectious cases other joints usually become affected within a year, or the knee recovers after suitable treatment, such as eradication of foci.

*Gonorrhea.* In cases of gonorrheal infection of the knee a history of primary infection may be obtained, the initial symptoms are acute, and other joints are often affected. The tendency of chronic gonorrheal infection in the knee is to improve slowly but steadily, whereas the acute type may rapidly go on to ankylosis.

*Syphilis.* This type of infection in the knee may be confusing, but in our experience the Wassermann or Kolmer test is almost certain to be positive, and other distinguishing signs are usually present. In this series 160 fixation tests for syphilis were made, but none was positive. It must be remembered that syphilis and tuberculosis may be present at the same time.

*Hemophilia.* In cases of hemophilia a positive family history may usually be obtained. In suspicious cases the blood changes should be considered, such as increased coagulation and bleeding time with decreased platelets.

*Sarcoma.* Rarely a sarcoma, which has either originated in the synovia or spread from the bone to the synovia, is difficult to differentiate. The history is usually short, but in one case the sarcoma developed after years of trouble with the knee. A positive diagnosis can only be made after exploration.

## TREATMENT

Insomuch as all of the patients comprising this series were subjected to resection of the knee joint, no mention will be made in this article of other types of treatment. None of the operations was in any sense of the word an erasion; all were frank resections. Resection was carried out in the doubtful cases only when the results of pathologic examination of tissue removed through a small incision were positive; the incision was then enlarged and the complete operation performed.

We have gradually developed the technique of our present operation. In the earlier cases of the series no attempt was made to remove large

amounts of synovial tissue; our aim was merely to expose the cancellous bone on both the tibia and the femur and to secure arthrodesis by their contact; it was not always thought necessary to remove the patella. Feeling that the ankylosis was often too slow in developing following such technique, we tried a form of internal fixation such as beef-bone screws and pegs, and even buried metal nails, but the latter often gave trouble and had to be removed. We then performed a somewhat more extensive operation removing the patella in all cases, fitting more accurately the resected surfaces, and holding the fragments in position by aid of two wire nails which were driven through the tibia into the femur, and left protruding to be withdrawn later. We have gradually gone on to more extensive excision of the affected soft tissues, and in the last few years have made use of a bone graft as a routine to hasten the development of union. Whereas previous to this more extensive operation, it was commonly nine months or a year before union occurred, it now quite commonly occurred in three or four months. Since 1918 we have not used drains no matter how "wet" the knee, and the wounds have healed by first intention in practically all of the cases, whereas when we used drains sinuses often persisted for many months. The amount of bone that it is necessary to remove varies, but the usual amount of shortening after operation is two and five-tenths centimeters (one inch). It should be remembered that in many cases the length of the affected limb actually increases previous to operation, so that often more than two and five-tenths centimeters is removed at operation with little resulting shortening. Shortening of an inch or thereabouts causes no inconvenience in walking, as it is better if a stiff leg is shorter. Even in the presence of extensive abscess formation, it is rarely necessary to excise as much bone as it would be if the surgeon insisted on resecting at a point above the abscesses. In many cases we have left large abscess cavities in the bone after thoroughly cleansing them, and have been astonished at the resulting prompt healing and bony union.

As we have mentioned, systemic treatment is essential. The ordinary recommendation of a high caloric diet and general hygienic measures must be explicit to each patient. Patients with active pulmonary lesions should be referred to a sanitarium for proper treatment. Heading the list of drugs stands cod-liver oil, which we prefer in the form of an egg emulsion. Heliotherapy can often be carried out at home, and in northern climates ultraviolet radiation should be provided in the winter.

## TECHNIQUE OF OPERATION

1. The pre-operative preparation consists of cleansing the leg with soap and water the day before operation, shaving the lower thigh, knee, and upper part of the leg, and the application of an alcohol dressing which is not changed until the patient is brought to the operating room. The leg is cleansed from the groin to the ankle with benzine and ether, and iodin is applied. The usual draping is carried out, the foot and leg being neatly

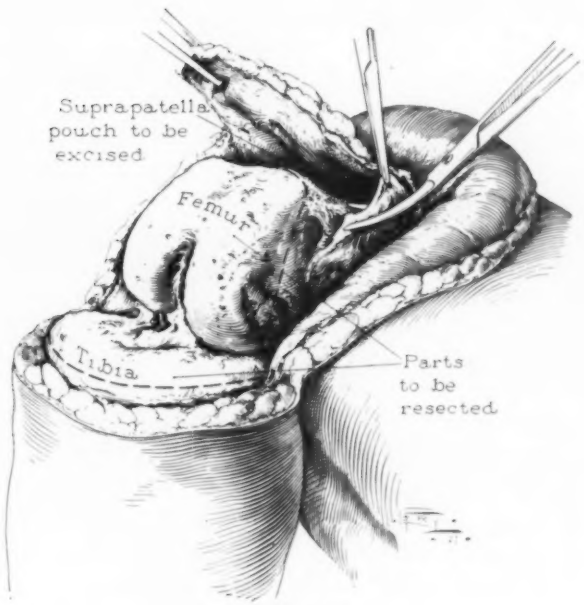


FIG. 1

Removal of soft tissue involved.

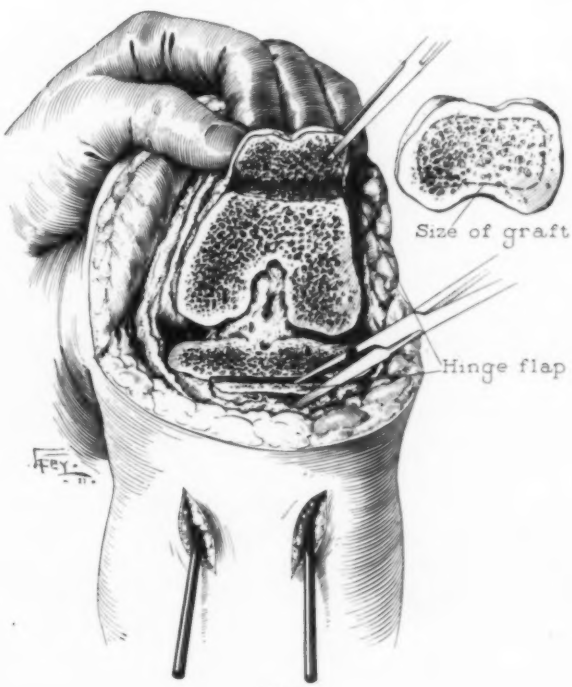


FIG. 2

Hinge flaps on the femur and tibia to be used to cover the graft. Wire nails in position.

wrapped in a towel as far as the upper third of the leg, and the wrappings held in place by a sterile bandage. The leg is elevated to deplete it of blood and a tourniquet applied over a folded towel in the middle third of the thigh.

2. The skin incision extends about two-thirds of the circumference at the joint-line, crossing just below the patella. The skin is dissected so as to clear the patella, and the joint is opened by severing the patellar ligament and the capsule, the incision being carried far enough back on both sides to permit acute flexion of the knee on the thigh. This movement opens wide the cavity of the joint and discloses the degree of involvement. The patella is dissected upward and is usually removed and kept sterile to use as a graft, or in certain cases it may be left attached and used with a pedicle.

3. The suprapatellar pouch and the synovia at the margins are thoroughly removed (Fig. 1). An incision is made through the soft tissues embracing the upper end of the tibia so that the saw can be introduced, and enough of the upper end of the bone is removed to expose fully the cancellous bone. If abscesses are found in the bone they are thoroughly curetted, the membrane lining then removed, and the cavity swabbed with iodin. Care is taken to saw off the upper end of the tibia squarely. The saw is then introduced into the condyles, no great care being taken to have the angle accurate, as we expect later to remove enough bone to provide the proper angle.

4. The knee still being held fully flexed, the upper end of the tibia is pulled forward on the femur, thus exposing the posterior capsule which is dissected out. We believe that it is essential to remove as much as possible of the affected tissues. More bone is then removed from the condyles, the amount depending on the angle of election, usually ten degrees flexion. This piece of bone is excellent for a graft as it is cancellous and rich in bone-forming properties. It is carefully kept warm in hot saline packs. Two small vertical incisions are made, one on each side of the median line in the leg about twelve centimeters below the upper end of the tibia, and carried down to the bone. Two wire nails are driven in a slanting direction through these incisions upward into the tibia until their points can just be seen beneath the surface of the bone. The chisel is driven vertically down along the anterior margin of the upper end of the tibia and the tissues with a good-sized leaf of bone pried outward, making a trough about two centimeters deep (Fig. 2). If there is enough of the prominence of the condylar area of the femur left anteriorly, the same procedure may be carried out on the femur, but often this prominence is lacking, so that it cannot be done.

5. All is now ready for the coaptation of the end of the bone at the desired angle. The ends are brought together and held firmly while the wire nails are driven through into the femur. The ends of the nails are left protruding through the skin. The graft is then pushed down in the trough prepared for it in the tibia; thus it has bony contact on two sides. It can be molded somewhat, as it will bend considerably without fracturing. If a

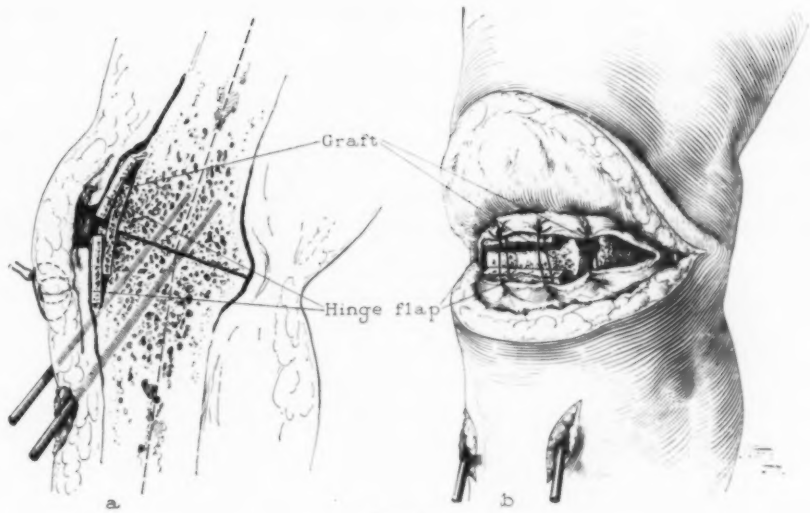


FIG. 3

Bone graft in place beneath the flaps and the wire nails driven into the femur.

flap has been secured on the femur it is tucked within the resulting crevice. If there is no such crevice, the graft is molded to the femur and held in place by catgut sutures extending from the soft tissues of the femur to the soft tissues of the tibia (Fig. 3). The remnants of the capsule are brought together as completely as possible and the skin closed. The leg is held vertically, care being taken to maintain the angle of flexion, and a thick dressing is applied firmly. The tourniquet is then removed.

6. Stockinet, which was previously applied to the foot and rolled at the ankle, is rolled up the leg to the groin, and eiderdown bandages are bound about the leg for padding. A plaster-of-Paris cast is then applied, extending from the toes to the groin. Canvas strips for suspension are incorporated in the cast at the foot and the knee.

7. The patient is put in bed and the leg suspended to an overhead frame so that the leg is free of the bed and the suspenders tend to force the lower fragment against the upper (Fig. 4).

8. Suspension is maintained for three weeks, at the end of which time the top half of the cast is removed, the leg carefully lifted out, the stitches removed, and the bottom half of the cast cleansed, and a new cotton dressing placed in it. The leg is replaced at the same angle as before and the wire nails removed. The latter come out easily at this time and cause little or no pain on withdrawal. A clean dressing is applied to the knee, and a few wraps of plaster bandage put around the old cast. Soon after this the patient is allowed up in a wheel-chair and perhaps on crutches. Six weeks after the operation a new cast, which is lighter and has shoulder straps to relieve the weight on the leg, is applied and the patient is allowed to go home on crutches to return in three or four months for examination and change of cast or the fitting of a brace.

### OPERATIVE MORTALITY

In the 211 cases there was no death that could be attributed to the operation. Two patients died from tuberculous meningitis within a year after operation; one of these died four months after operation, and one seven months after. It might be argued that the operation was a factor in this unfortunate complication, but it seems rather unlikely on account of the long interval between operation and the development of the meningitis.

### AMPUTATIONS

It is often claimed that in many cases in which resection is carried out for tuberculosis, amputation is necessary later. In five (2.5 per cent.) of the 194 traced cases amputation was subsequently performed. In one case it was performed for sepsis five months after operation; in one for non-union and sepsis four months after operation; in one for non-union and sepsis seventeen months after operation; in one for persistent drainage seven months after operation; and in one for non-union with a clean, healed wound. This amputation was done elsewhere against our advice; we felt that a bone graft should have been used instead.

### END RESULTS: DISCUSSION

Letters of inquiry were sent to all patients whom we had not examined recently. We received answers from 146, which, with our previously completed records, gave us final reports on 194 cases. Of the remaining seventeen cases five are too recent to report on; twelve were not traced.

*Mortality.* Seventeen patients (8.7 per cent.) died after having lived

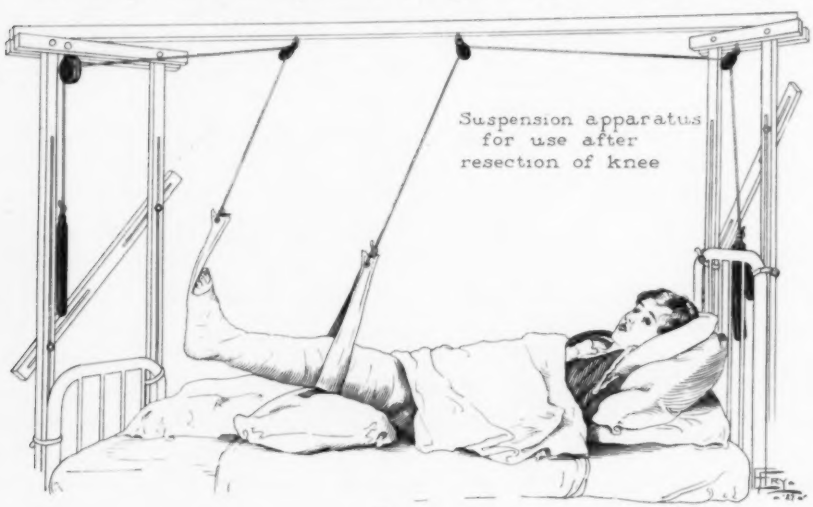


FIG. 4

Method of suspending leg. Pulleys arranged so that the tibia is forced up against the femur.

an average of four and forty-six hundredths years following operation; twelve and one-half years was the longest time. The seventeen deaths were due chiefly to tuberculosis in other organs of the body, such as lungs, kidneys, larynx and meninges. Two patients died from acute illnesses, influenza and scarlet fever. Eleven (71.43 per cent.) of the seventeen patients had active pulmonary tuberculosis at the time of operation. Eight of these secured firm union and were relieved of their disability and pain. Two had amputations.

*Non-union.* Twenty-two (11.3 per cent.) of the patients failed to secure bony union. Some of these, however, have slight motion with strong fibrous union and are quite satisfied. Four later had successful bone grafts; this leaves eighteen (9.27 per cent.) with non-union. No doubt many of these might obtain union by the bone-grafting operation. As might be expected union fails more often if patients are debilitated; we found active pulmonary tuberculosis in this group to be six times as frequent as in the others. Of the thirty-seven patients with active pulmonary tuberculosis operated on, eight (21.5 per cent.) failed to secure union. Bone-grafting operations were not performed until at least a year had elapsed. Of the 194 patients, 167 (85.9 per cent.) obtained primary bony union, and four with non-union returned for bone graft and union followed; thus 171 (88.3 per cent.) secured bony union. This leaves twenty-three patients (11.8 per cent.) who failed to get union. One of these died four months after operation from meningitis, so in reality there are but twenty-two in the non-union group.

*Pain and tenderness.* Twenty-three patients reported having experienced pain following operation. Most of these patients had not obtained union, although several with stiff knees had slight pain or rather aching during a change of weather or after an acute illness. The tenderness which was complained of by thirty-two patients (23.7 per cent.) was usually along the line of the incision and often due to an adherent scar, which will no doubt disappear.

*Sinuses.* Persistent sinuses are rare. Osteomyelitis did not develop at the site of the nail holes in any of the cases although some of the holes discharged for a considerable time. Four of the patients (2.06 per cent.) reported that they still have discharging sinuses. Six (3.09 per cent.) have had secondary abscesses drained.

*General condition.* Following resection the patient's general condition usually improved markedly; seventy-nine patients gained an average of twenty-seven pounds and only a few lost weight. The remaining patients were at normal weight at the time of operation and held that weight.

The type of work these people are now doing varies from the general duties of the housewife to hard labor, although many have had to seek lighter forms of employment.

*Period of disability.* The time necessary to secure union indicates the period of disability. We insist that the brace shall be worn until bony union is demonstrable both clinically and roentgenologically. Now that

we are using cancellous bone for grafts as a routine we expect firm bony union in from five to eight months.

Seven of our patients were between fifty and sixty years of age (fifty-one to fifty-six). These all obtained primary bony union. Three have died since operation, but all experienced the comfort of a painless leg for more than eleven years.

SUMMARY

This paper is based on the study of the records of 211 patients for whom the knee joint had been resected for tuberculosis. Definite information as to the end results was obtained concerning 194 patients. There was no operative mortality. One hundred and seventy-one patients (88.3 per cent.) secured firm bony union with good function. Union failed in twenty-two cases (11.3 per cent.). In four of these the bones were induced to unite by a bone graft, thus leaving eighteen (9.2 per cent.) in which union did not occur. The use of the bone graft as a routine and the improved technique of operation should give a lower percentage of non-union than is presented in the foregoing data. In five cases of the group, amputation was performed subsequently; in four, on account of continued drainage and non-union, and in one case, on account of non-union which might have been remedied by a bone graft. Of the 194 patients traced 177 are living; seventeen (8.7 per cent.) are dead. All but two of the seventeen died from extension of the tuberculosis; they lived an average of four and one-half years. The operation relieves the patients of a painful, distressing condition and restores them practically to full activity, so they can again take their place in industrial life.

## DISCUSSION

Dr. Fred H. Albee, New York, N. Y.: This paper of Dr. Henderson's is a valuable one. His deduction that in adults all tubercular knees of advanced pathology should be operated on is, I believe, absolutely correct. I think the profession has been rather slow in arriving at this opinion. I have read his paper very carefully and agree with all of his conclusions.

For a number of years I have employed a bone graft to hasten and to assure union, and I think Dr. Henderson's recommendation that this be employed in the original operation is very sound. Numerous cases operated on by others without inserting a bone graft have come to me later because of non-union, and I have had to use a bone graft to secure union, the patient thus being submitted unnecessarily to two operations.

As to the technique, I have practised a slightly different one. Instead of the wide, flat saw which Dr. Henderson uses, I use a very thin, narrow-blade saw, and remove the cartilage from the femur, following the contour of the condyles, and at the same time remove the cartilage and cancellous bone in a concave fashion so that they fit into each other. This is an advantage and simplifies the technique, particularly in adjusting alignment of tibia and femur, in that we have a circular convex surface fitting into a concave surface. In adjusting the tibia and femur, we can by following the joint contours get a few degrees of flexion, and at the same time secure a better contact of saw-cut bone surfaces more easily than if we sawed the bone off square. Too, we reserve a little of the length of the limb in this way.

I have changed my technique in the last few years for the reason that it has been my good fortune to do a few arthroplasties to restore motion after having done an

excision for tuberculosis. I showed one of the cases at the Interurban Orthopaedic Club two years ago, a case in which five years after the arthrodesis operation I did an arthroplasty. To meet such an exigency I now preserve the patella and use it *in situ* as a graft. All the infected bone is cut off its posterior surface with lower end of patella wedge-ended, and then an osteoperiosteal flap is turned up from just above the tubercle of the tibia. Later, when the arthroplasty is done, the patella serves a most useful purpose in the make-up of the new joint. It has grown firmly onto the femur and tibia, but can be chiseled away from them so as to be made use of in our arthroplasty.

I want to sound a word of caution about doing an arthroplasty on an old tubercular knee. There is only a small percentage of cases in which it is feasible. I should recommend waiting at least five years before ever considering an arthroplasty on an old tuberculous case, and then the case must be selected with the greatest care, as there is real danger of relapse of the old tubercular condition.

Dr. C. F. Eikenbary, Seattle, Wash.: I think we are all very much indebted to Dr. Henderson for presenting, as he has, such a large series of cases with such a definite knowledge as to the end results. It seems to me it does not leave much choice as to the treatment of tuberculosis of the knee in the adult. I think most of us feel that when we do a resection of the knee for tuberculosis we are simply making the best of a very bad situation. That is the best that our knowledge gives us at the present time. I have hoped, as you have hoped, that the time will come when something else will take its place, and when we will be able to conquer this situation without resorting to an arthrodesis operation. Certainly nothing else is in sight as far as the adult is concerned. Certain results may be obtained by heliotherapy, but the time element is so great that it cannot be considered, and so we must consider arthrodesis.

I had the pleasure of reading Dr. Henderson's paper last night, and there are some points brought out in the paper that he did not mention in his talk. In his paper he speaks of the differential diagnosis before anything is done. Of course that is essential. As to the procedure he follows, he depends very largely upon either the gross or microscopic findings at the time of operation. Perhaps I did not understand that correctly; I would like to ask Dr. Henderson to tell us whether this depends on the microscopic findings at the time of operation. I think he said the question of resection was deferred until after the report came in. If it was positive, he went ahead and did the resection.

I would like to take the time to say just another word about differential diagnosis and to report briefly a case. Dr. Henderson speaks of the differential diagnosis between sarcoma and tuberculosis. He states rightly that such a question could hardly ever arise, but I want to cite a case where that did arise. This was a case in which Dr. Langworthy and I made a diagnosis of sarcoma of the lower end of the femur. It was during the time when the Pacific Northwest Medical Society was holding its meetings in Spokane. Dr. Bloodgood saw the patient and saw the radiograph, and quite agreed in the diagnosis and recommended deep x-ray therapy. This was carried on for quite a while. He later drifted out of our care and came under the care of Dr. McChesney in San Francisco, who ruled out the question of sarcoma because of the length of time and who rather leaned to the diagnosis of syphilis; but while they were trying to settle this question the patient developed a large abscess and in the pus they found the tubercle bacilli. Later on, he came back under our care with a perfectly typical tuberculosis of the knee, and still later, Dr. Langworthy tells me, he had to have an amputation. While that may be very rare, it is possible and we must think of it occasionally.

Just a word about the technique of the operation. I dislike very much to use a transverse incision at any time, if I can possibly avoid it. As Willis Campbell used to say, "I like to cut with the grain". I think if we can do an arthrodesis of the knee by a very long incision, the so called Fisher incision, as spoken of a while ago in discussing derangements of the knee, it is preferable. On general principles I hope we will be able to get away from any foreign material in the knee following arthrodesis. I do not like it at all, though I recognize that we must use it occasionally. If possible, I think we should try to get away from it.

It is my feeling that a greater degree of immobilization is needed than Dr. Henderson suggests. Except in very thin persons, it does not seem to me we could get a proper degree of immobilization by a cast that goes from the groin to the ankle. It is my custom to carry the cast so that it includes the pelvis and foot. This is kept on for three months, when usually it is replaced by a shorter cast.

Dr. R. B. Osgood, Boston, Mass.: May I ask Dr. Henderson in what position he immobilizes the knee after operation. In the diagram he shows a considerable amount of flexion, with which position I quite agree.

Dr. G. E. Bennett, Baltimore, Md.: I would like to ask the approximate length of time it takes for ankylosis to occur.

Dr. Samuel Kleinberg, New York, N. Y.: The question of postoperative immobilization is an interesting one. I have found that at the end of three or four months there will be a bony ankylosis, but there is usually a good deal of local heat and that means that there is some residual inflammation. This persists for eight or nine months. I have taken my cue from that, and have continued immobilization of these patients for eight or nine months or possibly a year. I would like to ask Dr. Henderson what his experience is in regard to prolonged postoperative immobilization.

Dr. J. T. Rugh, Philadelphia, Pa.: I did not get from what Dr. Henderson said the percentage of cases he has had that have had a mixed infection. If all of us could get these cases operated on by this method, which is practically the method we all use, it would be an ideal situation. But the majority of cases I get, have extensive abscess formation and many suppurating sinuses and mixed infection. The plan of doing a bone graft in the presence of a mixed infection and covering it with a plaster or other solid dressing, I consider both unsurgical and disastrous.

Dr. James O. Wallace, Pittsburgh, Pa.: I would like to ask Dr. Henderson the type of anaesthetic he uses. I would also like to cite a case. I had a boy come down from Cresson Sanitarium with an old tuberculosis of the knee with a partially destroyed joint, and he insisted on an arthrodesis. I did not want to break up a fixation of the patella across the joint so I did an operation similar to the Davis operation. I made a lateral incision over the inner side of the condyle and with curved osteotomes I lifted out the periosteum all the way around. Then with a curet I curetted out the joint of all the inflammatory substance I could find. I then took pieces of the condyle off and packed them around the joint, really making a bone graft, and I closed up all the waste spaces. That boy had a solid union in three months' time.

Dr. Leo Mayer, New York, N. Y.: The question of the use of anaesthetics is, I think, a very important one. In two cases of tuberculosis of the knee, following the using of the usual ether anaesthetic, we found a rapid extension of the pulmonary process. In one of the cases we were forced to amputate. Since that time we have been using spinal anaesthetic for all our cases that require operative treatment.

The question Dr. Rugh asked is one that has bothered me more than anything else. That is the method we should employ in the case of mixed infection. I have found a simple operation under those circumstances, provided you do a radical removal of the bone itself, is the best method. I have myself left a drain in the sinuses, removing that as soon as the discharge became somewhat less. In all of these cases there has been long continued discharge of pus persisting from six to nine months after operation.

Dr. H. D. Barnard, Los Angeles, Calif.: I would like to ask Dr. Henderson, the approximate amount of shortening that results from this technique.

Dr. J. T. Watkins, San Francisco, Calif.: I have always used wood carver's tools. You can get them in any shape you desire. By following the condyles you can get identical cuts. I would probably not have the skill Dr. Albee would have with the saw, but if I used some kind of wood carver's tools, and followed the contour of the bone, I could cut it off quite accurately.

Dr. M. S. Henderson, Rochester, Minn.: (Closing the discussion). Referring to the question of diagnosis, we were able to make a positive diagnosis of tuberculosis of the knee in ninety per cent. of the cases before the knee was opened. In the cases in which

the destruction of the joint was not so extreme as to demand a resection on first glance after opening the joint, we only proceeded with the resection after the tissue was proven to be tuberculous by the frozen section method.

While the metal nails are foreign bodies, they are only in the knee for three weeks and they are a great comfort when it comes to putting on the cast.

We have encountered two cases of diffuse sarcoma of the synovial membrane when operating on a diagnosis of tuberculosis.

We do not consider it necessary to put on a spica cast embracing the hip. By running the cast only to the groin and suspending the leg, patients are very comfortable and the fixation is adequate.

I have seen bony ankylosis occur in three months. We expect it now, when using the bone graft, in from three to five months. Previous to using the bone graft we were satisfied if we got it in from nine months to a year. No definite time can be set for the wearing of apparatus; this must be controlled by clinical and x-ray findings.

Mixed infections, particularly in elderly people, are dangerous and many times amputations are the best course if this exists. However, resection can be done in the face of chronic draining sinuses due to low-grade infection. Heliotherapy is a great aid in healing sinuses.

Most of the patients comprising this series were given ether as an anaesthetic, although some had ethylene. There is danger, of course, in any anaesthetic, particularly in lung conditions, but I think that on the whole the dangers of anaesthesia are overestimated.

# THE CONSERVATIVE TREATMENT OF COMPOUND FRACTURES

BY WALTER G. STERN, M.D., CLEVELAND, OHIO

The logical difference necessarily existing between the treatment of simple and compound fractures, lies in the ever present danger of infection. The Great War of 1914 gave rise to grave and virulent infections, the like of which had not been experienced in modern medicine and surgery, and which were a "throwback" to the pre-Listerian days when the accepted treatment of compound fracture was immediate amputation. Fortunately the contingencies of the war disappeared with the advent of peace.

Debridement was a war-born concept and must justify itself in these normal times not by its efficacy in war infections, but by its superiority over the older conservative methods. The orthopaedic profession is already on record[1] as favoring the debridement method and it is to advocate the efficacy of the conservative methods that this paper is brought before the Orthopaedic Association for discussion. There have already arisen a goodly number of former active war surgeons who are charging that debridement had been carried out too extensively and in too many cases had violated the surgical tenet of "noli nocere".

The cardinal agent in combating infection is the resistance of the tissues themselves, and it is axiomatic that traumatized tissue is more prone to infection than healthy tissue. The animal experiments of Nathan have shown that, for at least an inch above and below the seat of a simple fracture, the soft parts are usually damaged; this certainly would be more true in compound fractures even of the simplest puncture type. When to the initial trauma, one adds the greater insult to the soft parts and bones by such operative procedures as bone plating and wiring, the application of Pelham bands, levering with metal levers, and the like, then one has added immeasurably to the chances of infection instead of having taken any steps towards preventing or combating such infection; and all for the sake of anatomical reposition and bony alignment, which trained orthopaedic surgeons should be able to secure by accurate manipulation, splinting and extension, and which would surely have to be immediately abandoned were infection to set in.

"Thus Delhi was lost for the sake of a fish."

Therefore, it is the firm conviction of the writer that in compound fractures, all *immediate* operative interference upon the bones or soft parts for the *sole* purpose of reduction and alignment is contra-indicated and to be condemned. Even the immediate use of such measures as ice tongs, Steinmann pins, etc., distal to the fracture are to be discouraged in cases in which the circulation is impaired.

CASE 1. E. G., a man, aged forty, injured in a motorcycle accident, had severe laceration of tissues of the leg, with fracture of both bones and a great deal of splintering and overlapping of fragments. The circulation of the foot was impaired, but not distinctly bad. Against our better judgment we were persuaded to insert a Steinmann pin through the os calcis in order to control the overlapping with traction, and the leg was put up in a Thomas splint. Within a week, the entire heel became gangrenous, and an amputation had to be performed just above the area of the compound fracture, where the wound was doing very well and there was no infection of the fractured bone ends. The loss of the limb was due to the insertion of the Steinmann pin alone.

Quite otherwise is it with the initial operation of debridement. Practically unknown before the war, it came into vogue as the only successful method of preventing the virulent infections already spoken of, and, under the slogan of "immediately converting a compound into a simple fracture", is in good repute in many of our largest clinics today. Unlike the bone operations already adversely referred to, its purpose is primarily to reduce the chances and dangers of infection and were there no other alternative or less destructive methods equally efficacious, it would perforce be the only legitimate method of treating compound fractures.

It has for its object the excision of the field or track of the trauma, thereby removing *en bloc* the infective agents together with *all* devitalized and susceptible tissues, including all free pieces of the fractured bones. The wound is then sewed up and primary union is anticipated. The truth is, however, that as practised by general surgeons and practitioners, by and large, primary union without some persistent oozing, drainage or infection is rarely attained; while the amount of tissue advised and often actually removed at operation is sometimes amazing; for instance, the articular cartilages of the joints, on the ground that the cartilages are exceptionally susceptible to infection. To disprove this at least seven cases from the writer's experience could be cited in this connection, where the ankle joint was widely opened by compound fracture (one case was further contaminated by a large amount of dirt in the joint), and which after careful lavage of the joint surfaces with mild antiseptics such as rivanol, acriflavine and the like, went on to primary healing without suppuration.

As far as the excision of devitalized tissues is concerned, few of us are so clairvoyant that we can prophesy with any great accuracy when any given tissue is going to live or how badly it must be damaged before it is certain to die and slough.

CASE 2. J. C., a boy, aged eight, was run over March 18, 1924, by a heavy truck, and received a most severe crushing of the lower third of the leg, with a compound fracture of both bones. The skin wound entirely circled the leg; the soft tissues were most severely crushed and apparently devitalized. Before turning the case over to the surgical department for immediate amputation, the resident called in the junior orthopaedist on fracture service who happened by the emergency room. After some deliberation they finally took a chance, decided against amputation and patched up the soft parts with as few stitches as possible; in one place they had to leave a skin gap of at least one and one-half inches over the crest of the tibia on account of the condition of the circulation in the skin flap. No debridement was attempted. The foot was blue and cold. The leg was placed in a pillow splint trough (not closed or strapped) and an

electric light bath was used to heat the foot, while the exposed bone was shielded from the heat and kept moist with saline sponges. No ice tongs could be used on the os calcis for immediate extension, on account of the poor circulation of the foot. The foot lived, the crushed tissues regained their vitality, did not break down or slough, and on the sixth day all immediate danger was over. There was considerable oozing from the wound but no infection. The tibia was next covered by mobilizing the skin above and below the gap and suturing with silkworm gut. Electric-light heat was then used on the entire limb and extension applied to the lower fragment. April 22, the wound was entirely healed. There were no fistulae and no oozing. April 25, a roentgenogram showed fair callus with some shortening and overlapping; June 1, the callus was firm and the patient was walking with excellent function.

Then there are structures that one dare not remove out of a compound fracture wound no matter how they look, as for instance the popliteal or brachial group of veins, arteries and nerves, etc. These must be treated conservatively by cleansing and antiseptics, even in an extensive debridement operation. The whole purpose of this contribution is to demonstrate that any conservative treatment that has any chance of saving such important structures as one dare not remove, should be efficacious enough to save the muscles, ligaments, cartilages, bones and other tissues in the same wound.

The strict conservative-antiseptic-rest treatment has yielded such satisfactory results in the past ten years that routine debridement has been forbidden in our operating rooms. Although this is a general hospital of 260 beds located in a large industrial, railroad and automotive center (The Orthopaedic Service at Mt. Sinai Hospital, Cleveland, has complete control of all fractures, both simple and compound, except the most severely crushed and mangled limbs, in which the soft-part injury is so extensive that the fracture is merely an incident in the debacle. Such cases are treated and usually amputated by the general surgeon and are not included in this paper.), where many cases in the private rooms are treated by non-staff men, but where the emergency surgery itself is performed by the interne staff, under the direction of a resident orthopaedic surgeon, all well drilled in the fracture technique to be described, there has never yet, in an experience of over 180 compound fractures, been a life lost, or a limb sacrificed and only one known ununited fracture came into existence due to the conservative treatment, *i.e.*, the avoidance of all operative interference with the area of fracture as far as surgically possible, and then following this up with reduction of the fragments, satisfactory fixation and complete rest. There have been some infections, some due to faulty carrying out of the technique, others in spite of excellent technique; few of great seriousness or stubbornness. In all of these drainage was easily maintained. There has not been a single case of persistent chronic osteomyelitis and but one case of non-union; there have been more numerous cases of slow union, all of which however, with one exception, were happily brought to union without operation within the six-month period.

Case 3. M. W., a man, aged twenty-four, admitted for a compound fracture of the lower third of the humerus, was treated conservatively; the arm was placed in extension

in a full Thomas arm splint, which was later modified so that the elbow could be flexed. Oozing persisted for eighteen days, after which the wound closed. At this time, the patient could grasp the handle of the L which kept his elbow at right angles, and no musculospiral paralysis was noted. In the fourth week, at his own request, the arm was put up in a plaster cast (body and arm) to enable him to travel, which he asserted was necessary so that he might retain his position with a factory in Kentucky. Instead of reporting for treatment in Cincinnati, he went directly to Wisconsin, where the cast was removed and sometime later, both a bone graft operation and musculospiral neurolysis were performed at a large western surgical clinic. The operating surgeon stated that the bone ends were not infected.

Two cases of gas gangrene occurred in this series, both cases saved by timely amputation. Lest these two unfortunate occurrences should be too arbitrarily charged against this form of treatment, they should be contrasted with nine other cases, three of which have come under the observation of the author.

CASE 1. Woman, aged forty-five, with compound comminuted fracture of lower third of femur, treated conservatively at other hands. There was also a stab wound of the gastrocnemius muscle of the calf on the same side, due to a piece of glass which had been withdrawn. Gas gangrene of foot and calf developed. Amputation of thigh was performed through the area of the compound fracture. This wound was healing; there was no infection; no pus; cultures from this region were sterile, special amaerobic cultures being made.

CASE 2. Male, aged fifty-one, had thigh crushed and bruised in a cave-in. There was a simple transverse fracture of thigh; no skin wound; no compounding. Gas gangrene of thigh developed on fourth day; amputation and death followed; cultures showed the Welch bacillus.

CASE 3. Boy, aged eleven, had crush fracture of elbow. Immediate debridement was done at other hands but gas gangrene developed on fourth day.

Furthermore, Baldwin and Gilmour report in the Annals of Surgery, February 1927, (LXXXV, 161), six cases of gas gangrene after compound fracture, all of which had immediate cleansing and debridement operations; some had in addition gauze drainage and in one case "radical drainage" was employed. In view of these nine cases the development of the two cases of gas gangrene in the series of the author cannot logically be charged against the conservative treatment employed.

As practised at Mount Sinai Hospital, Cleveland, the technique of the conservative treatment consists in shaving the skin (away from the wound which is to be protected with gauze) and the thorough cleansing of the parts with gasoline or ether, followed by alcohol and iodin. The parts are then draped as though for a major operation and the operator gloved and gowned. The protruding ends of the bones and the wound are now thoroughly cleansed with ether and alcohol, followed by iodin and alcohol. Foreign material is removed and small pieces of loose bone free from the mantle of periosteum presenting themselves in the wound can also be removed. Larger pieces even if in sight are allowed to remain[2]. Uncontrollable hemorrhage must be checked with hemostats or ligature, but a well trained personnel will rarely feel compelled to resort to this; but will rely upon firm bandaging to control the usual hemorrhage in these cases.

As far as possible, fingers and instruments are kept out of the depth of the wound. The bones are reduced beneath the skin by gentle manipulation and extension. When the opening of the skin is too small and difficulty is experienced in reducing the fragments, it is inadvisable to shove them back with a blunt instrument or the gloved finger. It is better to enlarge the skin wound with a pair of scissors and then reduce by manipulation and traction. Drainage or Carrel-Dakin tubes are never used. In one of our great eastern steel corporations, with scores of individual mills and subsidiary corporations with thousands of employees scattered throughout the central states, it has been the standard practice to "Dakinize" every compound fracture from the very beginning,—to treat it as a potential infection with the result (The writer has the word of many of the company surgeons to this effect and has seen many of the patients in consultation.), that the majority of all such cases become more or less infected, and resulting chronic fistulae, chronic osteomyelitis, sequestrae, etc., are not at all uncommon.

When the soft-part injury demands operative repair the tissues are gently and carefully reconstructed with as few stitches as possible and the skin always loosely sutured in such cases.

After the reduction a generous dressing is applied, the hemorrhage controlled by firm flannel bandages and elevation, and the limb is firmly and adequately held by proper splints. We use reenforced pillow splints for foot, leg and knee; Thomas splints for the hip and femur; coaptation splints for hand and forearm; and Jones or Thomas splints for elbow, arm and shoulder.

The patient is then put to bed and kept absolutely at rest for at least four or five days, often for one week. Opiates and sedatives are freely administered and the patient is never permitted to toss or thrash about in pain or delirium. X-rays are usually not taken before the fourth day and then always in bed. If the hospital is not built so that the bed can be wheeled into the x-ray room, then a powerful mobile unit should be purchased and bedside radiographs taken (The light portable sets are usually unsatisfactory.); but the patient should never be handled and lifted any more than is absolutely necessary.

In this connection one case might be of interest:

A. G., a boy, aged eleven, July 4, 1920, received a compound fracture of the tibia by falling from a chair. There was only a small puncture wound of the skin over the tibia to one side of the medial line. He was taken to a nearby hospital where the wound was scrubbed and the iodin technique employed. An attempt was made to reduce the fracture, after which it was firmly held in a pillow splint. (So far so good!)

July 5, in the morning, the boy was lifted from his bed to a cart, thence to the roentgen-ray table, and back to bed again. He complained later of having had pain on being moved. The position of the fragments being unsatisfactory as shown by the roentgenogram, he was later placed on the cart again, and taken to the operating table, where a second manipulation was performed.

July 6, in the morning, the process was repeated, except that the third manipulation was made under the guidance of the fluoroscope.

July 7, in the morning, he was again taken to the roentgen-ray room on the cart; and the roentgenogram now showed "complete satisfactory reduction of the fragments". That night the lad had a fever with temperature of 104 and a pulse of 140. The next day he was taken to the Mount Sinai Hospital, where the severely infected wound was enlarged and a considerable amount of bloody pus evacuated and the Carrel-Dakin technique instituted. Osteomyelitis followed and the perfect alignment had to be abandoned.

This lad had at least twenty more transfers from bed to cart, roentgen-ray table, operating table, etc., with its necessary handling of the fractured limb, etc., together with two manipulations, than he would have had, had the precepts laid down in this paper been observed.

The patient is placed upon a light diet, the bowels cared for by enemas on the second day, and then not fussed over. Eusol powder insufflations are used to control any odors from the dressings. Too much attention need not be paid to moderate rises in temperature. This may be due to a multiplicity of causes and of itself may look alarming, but unless the *limb itself* is clearly the seat of a severe infection, unless the patient is really

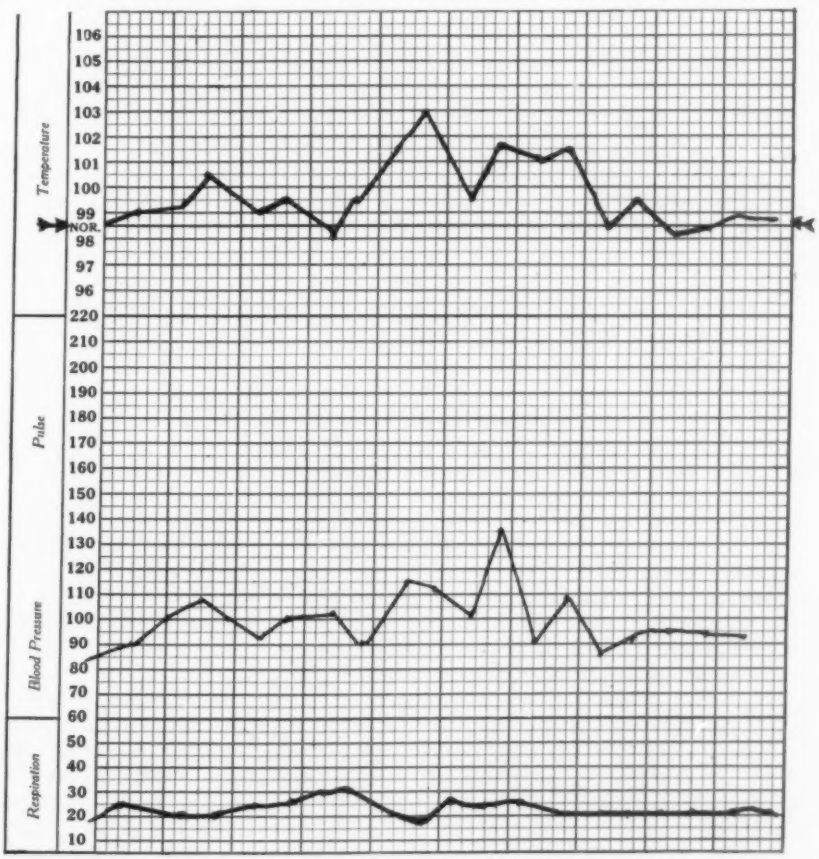


FIG. 1

Moderate rise in temperature in a case of compound fracture of the femur successfully treated by the conservative method alone. Thomas splint fixation applied in emergency room after cleansing, etc.

toxic and has a real leucocytosis, the wound need not be touched, except perhaps to change the dressings for inspection. Often a little blood-tinged serum runs out. The clinical observation of the limb checked by a blood count is a better guide as to the condition of the wound than is the temperature curve. (See chart, Figure 1.)

At the end of the fourth or fifth day,—sometimes a week,—all danger of primary infection is over and we then proceed to the final reduction and fixation, by the ordinary routine methods. Unless the wound secretion is small, a generous dressing is incorporated in the fixation apparatus or cast and provision is made for its easy removal and reapplication. As a rule the wound soon closes and subsequent dressing can be abandoned. We have never experienced any difficulty in satisfactorily reducing the fractures at this stage, the many published contraventions notwithstanding.

Considerable stress has been laid on the fact that debrided wounds seem to heal a few days sooner than wounds treated in the above fashion. On this point we cannot speak with any authority. We have had little experience with debrided wounds, except those done at other hands which did not give satisfactory results. We imagine the situation of the advocates of debridement is similar, so that neither side can draw any fair conclusions from their own experience with the other methods. We have kept no detailed records of the exact length of time each wound needed dressing, but the average is about eighteen days. But whether this is longer or shorter in either method is beside the point. It is the final results and these only that really count. If real bony union with good alignment can be secured by the non-operative method (The average time required in the cases here reported was eight weeks.), then its endorsement and advocacy by the orthopaedic profession will be a distinct contribution to the present treatment of fractures.

## BIBLIOGRAPHY

1. Massachusetts General Hospital Outline of Treatment of Fractures: Arch. Surg., VI, 172, Jan. 1923.
Cook, R. J.: The Results of Treatment Following Compound Fractures Occurring in Civil Life. J. Bone and Joint Surg., VI, 95, Jan. 1924.
Sherman, W. O'N.: Compound Fractures of the Femur and Open Fractures into Joints. J. Bone and Joint Surg., VI, 344, April 1924.
2. Clough, F. E.: The Fate of the Fragment: A Study of Comminuted Fractures. Surg. Gynec. Obstet., XLIII, 790, 1926.

## DISCUSSION

Dr. H. W. Orr, Lincoln, Nebr.: I find myself in disagreement with Dr. Stern; first, as to the necessity of waiting for any particular period for the adjustment of these fractures. It is my opinion that immediate anatomical adjustment is necessary not only for the union of the fragments but for the thing Dr. Stern is most concerned about, namely, the circulation and safety of the soft parts. The thing to do is to put the patient on a fracture table and secure the best possible alignment that can be obtained, even using a Steinmann pin or ice tongs, if necessary. In that way the circulation is restored almost immediately. No other manipulation is necessary and whatever other manipulation

is necessary can be done later and the circulation is not injured. It is my custom to put these patients into plaster with the Steinmann pin included in the cast. The wound is left open and no drainage tube is used. My practice regarding dressing is about the same as Dr. Stern's or more so. As a matter of fact, drainage is very slight and the patient goes on with much less reaction in the way of temperature than those shown by Dr. Stern.

With regard to using casts, many surgeons object to the use of casts on the ground that a cast cannot be used immediately or if used it cannot be disturbed for dressings. We have minimized the dressings to a very great extent. The amount of active trouble in the wound is very slight. The dressings are often not disturbed at all or if disturbed, at long intervals and the cast offers no difficulty from that standpoint. Moreover, instead of using a leg cast or spica it is our custom to use either a double spica for the femur or a double leg cast with crossbars which gives good immobilization of the extremity. That affords a much better chance for traction and a much better control of the patient as a whole.

Of course I fully agree with what Dr. Stern has said regarding the use of foreign material in compound fractures. We never use them, either gauze, tube or rubber drains. Debridement is sometimes necessary but certainly many wounds have been debrided entirely too much and the postoperative care has become too complicated. I would go so far as to say that many of the bad results that are blamed on the type of fracture or the character of the operation are in reality due to poor care. Or infection takes place and a wound infected as a result of postoperative dressings is no different from an infection during operation or other similar complications.

It is our idea as it is Dr. Stern's to simplify the immediate care and the operative treatment of fractures and this can be aided, too, by this plan of affording early and accurate apposition of the fragments and early immobility of the leg as a whole. I have some slides I wish to show.

1. This man was caught under a tractor and had a severe fracture of one shoulder, one arm, and both legs. He came to the hospital in shock, for an amputation of both limbs. The circulatory condition of both feet was found to be satisfactory. Within an hour he was put in plaster with a crossbar and Steinmann pins, with perfect immobilization. He went on to recovery. One piece of tibia three or four inches long was forced out through the skin and was dangling by a piece of periosteum and had to be cut off. He had a primary debridement and dressing. The secondary dressings were done three to six weeks apart, simply to keep him clean. The next slide shows the result in one leg, the one in which he lost the piece of tibia.

2. This is a rare case. This boy came to the hospital after four years and four operations, with a piece of wire between the ends of an ununited humerus. A sequestrum and the wire were taken out. For the first time the boy was put into an immobilization splint and kept there for four months. At the end of the first six weeks the first dressing was done. At that time the wound was found nearly healed. I did what most of us would not do. I put in a small chisel and chipped off some pieces of bone and in doing so set up a slight inflammatory process but did not disturb the cast. The next picture shows the patient at the end of eight weeks. He was then able to hold up his arm without support. At the time he first came in he was very septic and sick and could not move his arm. He got a perfect union of the humerus with a small amount of callus. He is now using that arm to drive a car. It shows the advantage of real immobilization even in the presence of infection in that kind of a fracture.

Dr. Robert Schrock, Omaha, Nebr.: I very much agree with Dr. Orr in his opposition to Dr. Stern's tardy attention to the position of the bone fragments in compound fractures. The optimum time for reduction of a fracture is when the patient and fragments are under definite control. The condition of the traumatized tissue, the circulation in the distal segments and the probability of infection, together with the resistance of the traumatized tissue, are the fine points for judgment in handling these badly compound fractures. These conditions change from hour to hour. The circulation

in the distal segment will, time and again, change perceptibly as the position of the fragments is improved. The factors in this improvement are the restoration of the normal contour of the extremity, the restoration of the fascial planes to their anatomic position and with this, the readjustment of tissue tension. Grossly damaged tissue should be conservatively removed, controlling the arterial bleeding by clamp and ligature. In most cases venous oozing is entirely controllable by elevation of the extremity. Moderate bleeding, not dangerous to the average patient is bringing into the wound an antiseptic agent more effective than can be brought from the chemical laboratory. The moderate oozing from the veins is also decreasing the infiltration of tissue so obstructive to fine capillary circulation. This is not at all unlike the multiple needle punctures used in plastic flaps to aid in overcoming the venous stasis, repeatedly a cause of failure if not relieved. Further control of the venous oozing is perfectly simple by compression dressings of sterile sheet wadding. Non-sterile sheet wadding is dangerous to use because it carries commonly the bacilla pyocyaneus. Repeated non-disturbing observation of the distal segments gives the basis for the best judgment of circulation. The temperature curve after the first forty-eight hours is the indication for disturbing of the dressings.

Splinting in an adequate manner, is an early requisite. This should mean fixation, comfortable to the patient and giving normal alignment and length to the extremity. These are factors in the tissue tension. Tissue tension is a factor in resistance to infection. I believe with Dr. Orr, that adequate splinting with consequent rest is a strong factor in preventing serious infections. Where moleskin traction is not advisable, direct bone traction is indicated, but this, in my opinion, should be as remote from the injury as possible. The Hawley heel pin superior to the os calcis, is a favorite with us. Its application is simple with local anaesthesia and this traction gives splendid control of the foot and leg.

Dr. Mitchell Langworthy, Spokane, Wash.: It seems to me that the idea that there is an argument between Dr. Orr and Dr. Schrock and Dr. Stern is not true. I take Dr. Stern's word that he has a series of cases treated by this method and I take Dr. Orr's and Dr. Schrock's word that they have success with the particular method they employ. I think in Dr. Stern's series of 180 cases, if it happened that a percentage of those cases had been infected with gas bacillus organisms, his series would not have been so good. The same thing applies to the cases the other gentlemen mentioned.

I do not have a big hospital service. The cases I see are the cases that look so bad when the general man sees them that he knows at once that he does not want to have anything to do with them. I think many of us are in the same position; in other words, the only ones we get are those that are badly chopped up, with the bone sticking out two or three inches and are the severe cases out of the total number that come into our hospitals.

For these cases I have not the answer I am looking for from this discussion. I checked over hurriedly before I came to this meeting the compound fractures that have come to me and which really fall into this class we are talking about. Some of these have come in as soon as they were hurt. More of them came in a week or sometimes later. For those that came immediately it was necessary to choose a method of immediate treatment. I have tried the several methods discussed and am surprised, in checking up, to note the serious results that followed my treatment. It was interesting to me to note that I had serious results following conservative treatment and serious results following debridement; serious results from both styles of treatment. I think that until we have some further knowledge along the line of treatment, in any series of cases the results are going to depend not on the particular technique that is used, so much as on the infecting organisms. It has happened that I have seen a lot of gas bacillus infection. Why I do not know. Possibly that same type of infection does not occur in Dr. Stern's patients. The thing I am concerned about particularly is how I can tell beforehand what this individual patient is going to do.

I have in mind a fracture of the femur with a little puncture wound which I treated

conservatively and which developed a gas bacillus infection, causing death. I also have in mind a recent fracture of the tibia which I cleaned out somewhat thoroughly, possibly not as thoroughly as I should, and that patient is now dead from a gas bacillus infection. So how in the world we are going to arrive at a practical treatment in a particular patient is to me still a mystery.

DR. ORR: What did you do with the two patients, the fracture of the femur and the fracture of the tibia?

DR. LANGWORTHY: The young woman with the femur I did not do anything with. She went down so rapidly that I did not operate. The gas bacillus infection developed after a period of three or four days. The fracture was reduced perfectly and in a cast. It was one of those simple transverse fractures. The boy, I had just the other day, got a gas bacillus involvement on the second day after I cleaned out the wound. I wish now I had amputated. I did not amputate. I merely made long incisions.

I want to bring up for discussion the matter of using a tourniquet on these cases which are so toxic that you think there is no use to amputate. Dr. Akin, of Portland, Oregon, has just told me of a good result with this method.

DR. WALTER STERN, Cleveland, O. (Closing the discussion): To answer Dr. Langworthy, this is not so much a question of what to do with the case after it arrives in expert hands, but rather what we should do to teach the profession at large as to how to treat these cases at first hand so that poor results would not follow so frequently. I do not think we should teach them that debridement or bone operations are the proper things, for in the long run they will not get as good results as they will get by using a strictly clean, conservative method. We are surprised, we are amazed to go through the cities and villages of our central states that have small but efficient hospitals, and see what wild ideas the local surgeons have developed regarding compound fractures. One prominent surgeon in a large industrial center fills his fractures full of Dakin tubes and all over Ohio that method is being practised; another group of men have the idea they should pack with iodoform gauze; then many of the younger men who were in the army cut down over the fracture and either plate or wire it. We see the resultant infections from these various open operations in an untoward proportion of cases, hence this essay on the conservative treatment.

I agree with Dr. Orr that accurate fixation is the keynote. As to the use of Steinmann pin and the ice tongs, in my experience the immediate use of these things with a damaged circulation was bad. I rejoice that Dr. Orr can use the Steinmann pin and the ice tongs in the case of bad circulation and get away with it.

I do not think that the dictum of delayed reduction is as serious as it may sound, because I have shown you lantern slides of several series of fractures that were reduced after eight or ten days, and a few which, on account of severe damage, impaired circulation or other causes, were not reduced for several weeks. You will recall one comminuted fracture of the tibia with upward dislocation of the head of the fibula to two inches above the knee joint, which was completely and perfectly reduced by a Steinmann pin four weeks after the injury, the limb in the meantime being supported by wire splints to facilitate dressings. A great many of our cases are reduced at once in the emergency room, such as fractures of the wrist, ankle, etc.

We believe by our clinical results we can teach the general practitioner and the general surgeon that this is the preferable method of treatment in compound fractures.

# END RESULTS OF RAMISECTION IN SPASTIC PARALYSIS*

BY STEELE F. STEWART, LOS ANGELES, CALIF.

The disabilities of the infantile spastic paralytic are due: First, to an inability to actively initiate motion in certain muscles, or muscle groups. Second, to an inability to inhibit or modulate reflex or active phenomena, which results in a decreased power of rapid accommodation, ordinarily referred to as rigidity. Third, to disturbances of equilibration which obviously may result from the inability to accommodate rapidly or to actual disturbances of the vestibular mechanism,—a problem now receiving our consideration. Fourth, to involuntary activity, choreiform motions, associated movements, tremors and athetosis. Fifth, to the deformities resulting from muscular and fascial contracture and to bony deformities due to constant muscular strain on growing bones. Besides these physical difficulties there is frequently the necessity of working with impaired and untrained mentality that is at times insuperable.

The historic approaches to the spastic problem are:

(1) *The relief of contractures* which abolished deformity but did not greatly facilitate motion.

(2) *Muscle transplantations* were attempts supposedly to substitute a strong muscle for a weak one. These relieved contractions and bettered positions and facilitated the maintenance of position, but rigidity remained.

(3) *The posterior rhizotomies of Forster* sought to break the reflex arc on the supposition that the spasticity was a result of exaggerated reflex activity. The results were severe neurological mutilation, a high mortality and no great functional improvement.

(4) *The partial motor neurectomy of Stoffel* was advocated with the idea of equalizing motor activity controlling a joint. This gave the best results of any procedure up to 1922.

Each procedure helped to define more clearly our knowledge of spastic paralysis, some negatively, some positively. The fasciotomies and myotomies quickly demonstrated the fact that the problem was greater than one of deformities. Muscular transplantation revealed that it was a problem of rigidity more than of muscle strength or muscle weakness. Posterior rhizotomies showed that the problem was more than one of reflex activity. Partial motor neurectomy theoretically should be equivalent to the end result of a well executed and well trained muscular transplantation, but the results were better because of an increased ease of performance.

The problems that remained at the beginning of this decade were much the same as they were a decade earlier, namely:

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

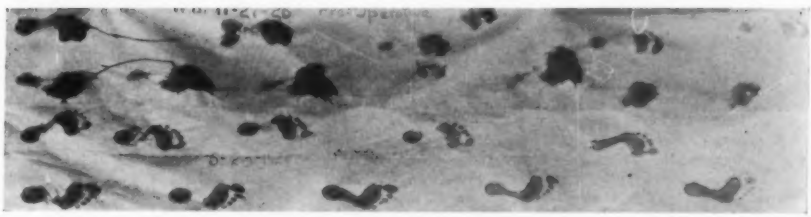

FIG. 1

Tetraplegia: Shows improvement in character of heel markings and quality of foot prints, following four ramisections.

(1) To motivate paralyzed muscles,—the least of the difficulties.
(2) To reduce or abolish the rigidity of the parts.
(3) To improve equilibration.
(4) To abolish involuntary activity.

The partial motor neurectomies had evidently touched the answer to the major problem in part. But did it accomplish this by a severance of the motor or sympathetic fibres? For muscle has a dual enervation.

In the early years of the present decade Royle and Hunter began to attack the problem from the side of the sympathetics and their studies would lead to the following difficult concept:

TABLE 1

| *Distribution* | *Sex* | | *Operations* | |
|---|---|---|---|---|
| | *M* | *F* | *Cervical* | *Lumbar* |
| Monoplegia | | 1 | | 1 |
| Right Hemiplegia | 4 | 5 | 8 | 8 |
| Left Hemiplegia | 3 | 2 | 3 | 5 |
| Paraplegia | 1 | 7 | | 16 |
| Triplegia | | 2 | 2 | 4 |
| Tetraplegia | 1 | 1 | 2 | 4 |
| Total to June 10, 1927 | 9 | 18 | 15 | 38 |

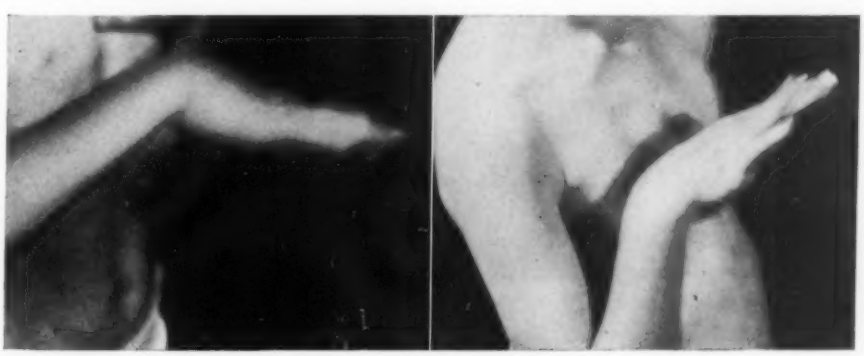

FIG. 2A FIG. 2B

Right hemiplegia: Shows ease with which voluntary extension of the hand is maintained and slightly improved posture, following cervical ramisection.

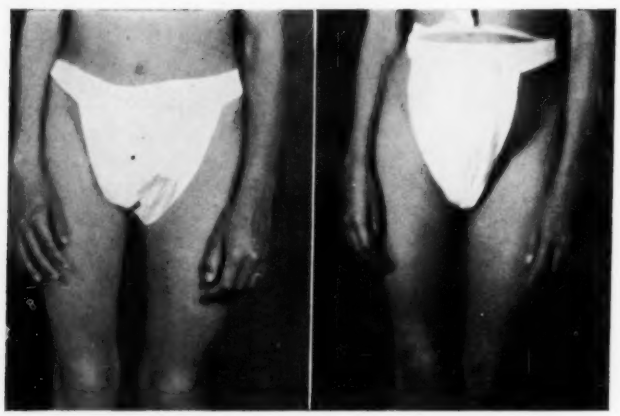

FIG. 3A FIG. 3B

Right hemiplegia: Shows relaxation of right hand following cervical ramisection.

The frontal lobe apparently tethers all our activities; remove its action by alcohol or ether and the priest may become a blackguard. A frontal tumor notoriously changes behavior. This lobe or a portion of it is connected with the cerebellum by the frontopontocerebellar tract. This portion of the cerebellum in turn is apparently connected with the sympathetics through a pontine nucleus and with the vestibular mechanism through Deiters's nucleus.

In spastic paralysis some portion of the frontopontocerebellar tract is injured, frontal inhibitions are removed, and the cerebellar centers pour unmodulated impulses out to the peripheral nerves and muscles through the sympathetics. A division of the sympathetic rami should theoretically result in placing the affected parts under greater willful control.

Practically it has been found that:

(1) Muscular weakness has not been modified directly.

(2) Rigidity apart from contractions has been reduced or abolished in each of the twenty-seven patients operated on. This is evidenced both subjectively and objectively. All the older patients have voluntarily mentioned the increased ease of doing things. Objectively, the flexed and pronated arm has given way to a more normal position, following each cervical ramisection. Patients who used the hand only as a pusher now use it to pick up objects, turn door knobs, and button their clothes. In the leg the rigid knee, either in flexion or extension, has begun to act more normally. Scissors gaits have decreased, equinus has disappeared, no longer are the toes dragged, except where an unoperated contracture remains, and children who could not run before, do so now. This sounds like "pink pills for pale people".

(3) Coordination has improved as patients who did not play ball, now do so; right hemiplegics who could not write, now do so. Patients no longer clump their heels, and those who stood on their full foot but walked on their toes, now walk full footed.

(4) There has been improvement in equilibration as is evidenced by walking alone, walking backwards, standing on one foot and hopping. This subject will be the theme of a later communication.

## TABLE 2

### Effect of Ramisection on Rigidity

*Upper Extremity*

| | *Oppose thumb and fifth finger* | | *Grasp large objects* | | *Grasp small objects* | | *Turn crank* | | *Turn knob* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* |
| Right Hemiplegia | 7 No | 3 Yes | 6 No | 6 Yes | 7 No | 6 Yes | 5 No | 5 Yes | 1 D<br>5 No | 1 Easy<br>4 Yes 1 No |
| Left Hemiplegia | 2 No | 2 Yes | 2 No | 2 Yes | 2 No | 2 Yes | 2 No | 2 Yes | 2 No | 2 Yes |
| Triplegia | 1 No | 1 No | 1 No | 1 Yes | 1 No | 1 Yes | | | | |
| Tetraplegia | | | | | | | 1 Yes | 1 I | 1 Yes | 1 I |

*Lower Extremity*

| | *Rigid Knee* | | *Equinus* | | *Drags Toe* | | *Run* | |
|---|---|---|---|---|---|---|---|---|
| | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* |
| Monoplegia | 1 E | 1 N | 1 Yes | 1 No | 1 Yes | 1 No | | |
| Right Hemiplegia | 4 F<br>2 E | 3 N 1 C<br>2 N | 6 Yes | 6 Yes | 5 Yes | 5 No | 2 No<br>2 P | 2 Yes<br>2 Well |
| Left Hemiplegia | 4 F<br>1 E | 2 N 1I 1 C<br>1 De | 5 Yes | 5 No | 5 Yes | 5 No | 1 P<br>1 No | 1 Well<br>1 Yes |
| Paraplegia ♯ | 15 F<br>1 E | 1 N 4 S<br>10 I<br>1 De | 13 Yes | 3 No 1 S<br>2 C 6 T<br>1 De | 14 Yes | 6 De<br>6 No<br>2 I* | 5 No<br>2 P | 3 Yes<br>2 No<br>2 Fair |
| Triplegia | 2 Het<br>2 F | 2 He<br>1 I 1C | 2 Yes | 2 T | 2 Yes | 2 No | 1 No<br>1 P | 1 No<br>1 Fair |
| Tetraplegia | 2 F | 2 De | 2 Yes | 2 T | 2 Yes | 2 No | 2 No | 1 Yes<br>1 No |

♯ The conditions before and after operation are not always alike on the two sides, hence each foot is recorded.

* Patient could not walk alone before and needs tendoplasty.

† Hyperextension due to previous surgery and overstretching.

C–Contractures. D–Difficult. De–Decreased. E–Extended. F–Flexion. I–Increased. N–Normal. P–Poor. S–Slightly. T–Tendoplasty.

Note: This work extends over a period of two years and the same data is not available on all patients, as the work has developed gradually. Furthermore, complete end results have not been obtainable in all cases and hence the recorded numbers refer in each instance only to complete cases.

Fig. 4

Paraplegia: This child could neither stand nor walk pre-operatively. Post-operatively the scissors gait has somewhat decreased, dragging of the toes is lessened, heel comes in contact with the ground most of the time and the patient can stand alone. She requires tendoplasty of adductors and knee flexors, following double lumbar ramisection.

## TABLE 3

### Effect of Ramisection on Disturbances of Coordination

| Distribution | Upper Extremity | | | | | | Lower Extremity | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Finger to nose | | Play * ball | | Write | | Heel to knee | | Scissors * gait | | Stance * gait | | Clump heel | |
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Monoplegia | | | | | | | | | | | | | 1 Yes | 1 Yes† |
| Right Hemiplegia | 2 No | 2 I | 7 No | 4 Yes<br>3 No[1] | 3 P<br>5 No. | 2 G 1 F<br>3 Yes<br>1? 1 No | 1 No | 1 Yes | 1 Yes | 1 No | 5 Yes | 5 No | 2 Yes | 2 No |
| Left Hemiplegia | 1 No<br>2 P | 1 P<br>2 F | 5 No | 1 No[2]<br>1?<br>3 Yes | | | 2 P | 2 F | 1 Yes | 1 No | 4 Yes | 4 No | 1 Yes | 1 No |
| Paraplegia | | | | | | | | | 6 Yes | 2 D<br>3 No<br>1? | 4 Yes | 3 No<br>1 C | 1 Yes | 1 No |
| Triplegia | | | 2 No | 1 No<br>1 Yes | 1 P | 1 F | | | 1 Yes | 1 No | 1 Yes | 1 No | 1 Yes | 1 Yes |
| Tetraplegia | | | | | | | | | 1 Yes | 1 No | 1 Yes | 1 No | | |

* May be due to primary incoordination or primary rigidity.

† Has not come in for reeducation.

No [1]–All girls. No [2]–Cooperation and mentality poor. D–Decreased. F–Fair. G–Good. P–Poor.

## TABLE 4

### Disturbance of Equilibration

| | *Sit* | | *Stand* | | *Romberg's* | | *Walk forward* | | *Walk backward* | | *Stand one foot* | | *Hop* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* | *Pre* | *Post* |
| Monoplegia | | | | | | | | | | | | | 1 No | 1 No* |
| Right Hemiplegia | | | | | | | | | 2 No | 2 Yes | 3 No | 3 Yes | 3 No | 3 Yes |
| Left Hemiplegia | | | | | 3 Yes | 3 No | | | 3 No | 3 Yes | 3 No | 3 Yes | 3 No | 3 Yes |
| Paraplegia | | | 4 No | 1 B<br>3 A | 2 Yes | 2 No | 4 S<br>1C B | 2 S †<br>2 A<br>1 A | 4 No<br>1 D | 2 No †<br>1 A 1 S<br>1E | 7 No<br>1 D | 3 A<br>4 No<br>1 E | 7 No | 1 A<br>6 No |
| Triplegia | | | | | | | | | 2 No | 2A | 2 No | 1 No<br>1? | 2 No | 2 No |
| Tetraplegia | | | 1 S | 1 A | 2 Yes | 1 No<br>1? | | | 2 No | 1 AD<br>1 AW | 2 No | 1 Yes<br>1? | 2 No | 2 No |

Patients with lumbar operations are the only ones considered.
Only positive disturbances pre-operatively are considered.
A–Does it without support. B–Braces. C–Crutches. D–Done with difficulty. E–Done with ease. S–Does it holding on to somebody. W–In water.
*Too young to do this normally. † One is blind as well as paraplegic, one still requires tendoplasties.

FIG. 5A

Left hemiplegia: Postoperative shows full impression of left foot without dragging, following cervical and lumbar ramisection.

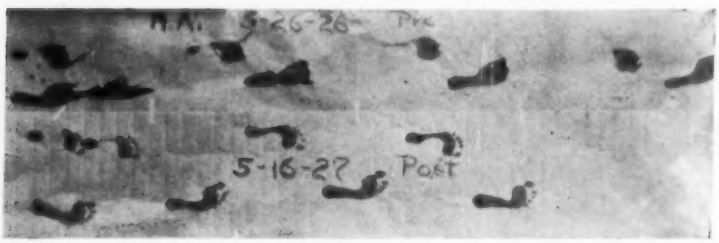


FIG. 5B

Left hemiplegia: Postoperative shows disappearance of scissors gait and equalization of stride. Contracture of tendo Achillis required tendoplasty.

TABLE 5

EFFECT OF RAMISECTION ON THE REFLEXES

| | | | |
|---|---|---|---|
| Knee-jerks exaggerated | before 18 | Not changed 16 | Normal 2 |
| Knee-jerks maintained | before 18 | Not changed 2 | Decreased 2 Normal 14 |
| Knee-jerks built up | before 16 | Not changed 2 | Decreased 2 Normal 14 |
| Shortening reaction | before 4 | Not changed 0 | Decreased 1 Normal 3 |

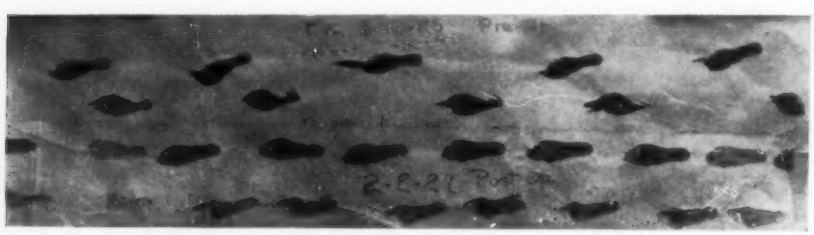

FIG. 6

Paraplegia: Postoperative shows disappearance of dragging toe and internal rotation and appearance of normal heel prints.

FIG. 7

Paraplegia: Postoperative shows disappearance of scissors gait and dragging of toes.

FIG. 8

Left hemiplegia; Shows disappearance of bull-dog gait and dragging of toes; this appeared following lumbar ramisection on a very obstreperous individual of low mentality, who received no physiotherapy.

TABLE 6

CHOREIFORM MOVEMENTS

| | *Pre* | *Post* |
|---|---|---|
| Right Hemiplegia | 1 No 7 Yes | 1 No 7 De |
| Left Hemiplegia | 1 Sl<br>1 No 1 Yes | 1 No 1 De 1 Sl |
| Triplegia | 2 Yes | 1 Yes 1? |
| Tetraplegia | 1 Yes | 1 De |

No athetosis, associated movements, or tremors in this series.

De--Decreased. Sl--Slight.

(5) Organic contractures and bony deformities are not relieved by ramisection.

(6) The effects on involuntary motion are best shown by the accompanying table (Table 6).

(7) Incidentally, following cervical ramisection, three cases with heterophoria have shown marked improvement in the squint, three cases of known speech difficulty have shown improvement after the cervical operation, and drooling has disappeared in one case.

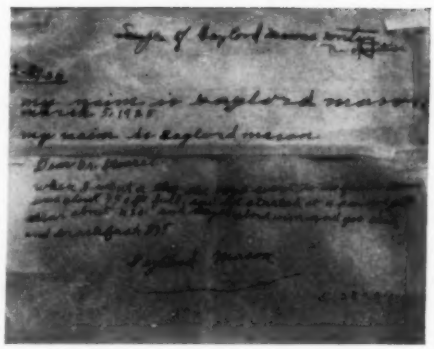

FIG. 9

Changes in writing following cervical ramisection in an eleven-year-old boy. First specimen is pre-operative. Illustrates change in ability to coordinate.

Some of these results have been complete and practically perfect. Others have been less satisfactory, due to:

(1) Unoperated contractures.

(2) Low intelligence.

(3) Lack of cooperation.

(4) Imperfect operation.

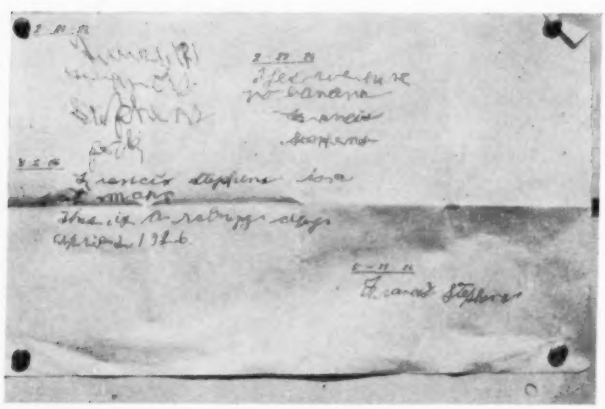

FIG. 10

Changes in writing following right cervical ramisection in a twelve-year-old boy. Earliest specimen is pre-operative.

(5) The supposition that the whole problem of rigidity has not been solved; there are other intra-spinal tracts that are associated with the sympathetics in governing these phenomena after the manner of the two motor bundles in the cord.

In each operation all has been accomplished that was attempted. It, therefore, seems probable that, allowing for the first three explanations, the last supposition is correct and awaiting further study. That Royle and Hunter have added to the knowledge and treatment of spastic paralysis is certain. When associated with the relief of deformities, ramisection constitutes the most perfect method for the treatment of certain cerebral spastics that has yet been suggested.

NOTE:—The discussion of this paper will appear in a later issue of the *Journal*.—*Editor*.

# THE TREATMENT OF ACUTE OSTEOMYELITIS BY DRAINAGE AND REST*

BY H. WINNETT ORR, M.D., LINCOLN, NEBRASKA

In order to clear the atmosphere it seems desirable to state exactly what it is that requires emphasis in the treatment of wound infections and of acute osteomyelitis in particular.

In the method proposed in this paper for the treatment of wound infections, especially those affecting bones and joints, there are three principal points. It must be borne in mind, however, that the point with which we are most concerned at this time is the desire to do away with the employment of the active antiseptic methods now in common use in the postoperative treatment of infected wounds.

It is believed that the antiseptic methods now in general use not only fall short of being truly antiseptic, but that as a rule, partly by inefficiency and partly from the manner of their use, they add to or complicate rather than prevent or relieve infections.

In this paper is advocated a special type of drainage in acute osteomyelitis and the immobilization in plaster-of-Paris of all inflamed parts. Most important, however, is the advocacy of the discontinuance of active antiseptic methods in the after-care of osteomyelitis, compound fractures, septic joints, etc.

Lister taught us the fundamentals of both asepsis and antisepsis. Lister's teachings with regard to asepsis have been understood and his aseptic methods and technique have been developed and improved. Lister's teachings with regard to antisepsis, however, as related to the treatment of wounds in which infection has become established, have been largely misunderstood. Such treatment at the present time is not only no better but on the whole rather worse than in Lister's time.

1. *Adequate drainage.* Of course, this is not new. Drainage of infected areas is commonly taught but poorly practised, especially as regards infections in bones and joints. For acute osteomyelitis incisions through the skin or even through the periosteum are insufficient, but these have been common practice. Drill holes into the diaphysis at the point of most severe infection, as advocated by Starr, is, of course, much better treatment than periosteal drainage, but inadequate in many cases. Larger openings into the infected area are usually necessary, and it should be emphasized that the entire area must be left open. Drainage through tubes or leakage between sutures is inadequate. This entire program of drainage

*Read before the Annual Meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

was perfectly described by Dr. E. H. Nichols in his article in Keen's Surgery in 1907. Dr. Nichols leaves us at the end of his drainage operation, however, without a suggestion as to the subsequent care of the wound or the patient in the acute cases. He does say, however, that in the chronic cases he has found methods of filling bone defects by sponge, skin flaps, blood clot and Mosetig Moorhof paste useful only in selected cases. The author has advocated large openings into the bone in every case. For the method of dealing with a primary acute osteomyelitis, however, he is indebted to Dr. Osgood for an important suggestion. Dr. Osgood has pointed out that the primary focus is commonly limited early to the cancellous bone of the metaphysis. Having made a window into this area it is quite important to limit our surgical procedure so that neither the epiphysis nor the diaphysis is invaded, if they have so far remained uninvolved. If this primary drainage of the metaphysis is properly timed and is adequate, a prompt and brilliant recovery without extension and without complications may be obtained. If on the other hand the surgical procedure is the means of carrying infection either into the uninvolved epiphysis or into the medulla of the diaphysis, great damage may be done. Accuracy in diagnosis either before or during the surgical procedure becomes, therefore, most important. The exposure of the infected area is partly to reduce the amount of infection present, but chiefly to give a clean field for the application of the sterile dressings that are to serve to exclude secondary infection from the diseased area. In other words, no attempt is to be made to remove all diseased bone tissue.

2. *An aseptic dressing of considerable extent* (vaselin pack) is to be placed in and about the wound, and it is not to be disturbed for a number of weeks or until healing is thoroughly established. No drainage tubes or sutures are employed. This is simply an elaboration of the method of Lister himself and is not new except for its application to acute and intramedullary bone and joint infections. A window having been made into the infected area, the wound and surrounding skin are carefully dried, painted with tincture of iodin and the entire wound packed open and covered over with a sterile gauze-vaselin mass. This is not to be disturbed for subsequent dressings until healing is well established. This is a matter of several weeks. Subsequent dressings are to be done in the same manner and at similar or longer intervals. Two to four dressings are usually sufficient to secure healing. All of the writer's earlier suggestions to this effect were met by the response that it could not be done. For several years, however, this method has been employed successfully in every case in which it has been attempted and, although the number of cases is not large, there has been no death in the series. This cannot be said for any other series of cases of acute osteomyelitis known to the author.

3. *Immobilization of the affected part in a well fitting plaster-of-Paris cast.* Makeshift splint methods will not do; the cast must be applied in such a way that the affected part is well fixed in correct position and free from muscle spasm. Moreover, the wound area should be well covered

with plaster and is not to be opened except for definite and urgent signs of secondary trouble. In from three to six weeks the healing process will have become so well established that if, for change of dressing, reapplication of cast, or any other good reason, a change becomes necessary, it may be done. But it should be done under the same conditions of asepsis and protection of the parts against irritative motion as were observed at the original operation and the secondary period of non-disturbance should be as carefully observed as the first. Immobilization should not be discontinued until healing is complete.

By this method:

1. The patient is relieved at once.
2. Complications are avoided.
3. Convalescence is simplified.
4. Labor and materials are saved.
5. The patient makes an earlier recovery with a minimum of deformity and disability.

One of the points strongly emphasized by Lister, and which has been pretty generally disregarded ever since, is that suppuration (discharge) is greatly aggravated by the application of antiseptics directly to the wound surface. Quite commonly patients are seen, who are pouring out quantities of secretion only exceeded by the amounts of irrigating, and irritating fluids poured in by the overzealous surgeon. By the rest method advocated by the author these wounds will remain quiet and dry for weeks, because of the fact that they are protected both against motion of the part and against daily irritation by antiseptics and exposure to new infection.

During a certain stage of my experience in France it fell to me to send some thousands of men with bone and joint wounds from France to the United States in casts. If I had sent any of these on shipboard for transportation to the United States without making windows in the casts for the daily dressing of open wounds I should probably have been censured or worse, and at that time I should not have thought of doing so. Yet later observations show that most of those men would have had less suffering, fewer complications, and better ultimate results if they had been prepared according to the method now advocated, put in closed casts and left undisturbed during the entire period of transportation to the United States or longer.

The two things that are responsible for most wound complications (whether in the wound or in other parts of the body) are secondary dressings and failure to immobilize the inflamed part. Mixed infection and irritative motion of inflamed parts are the two things most to be feared in all wound treatment.

Failure to appreciate the principles involved in this kind of treatment or unwillingness to take pains in carrying out the essential details may either or both be responsible for failure to obtain good results; and it is very common for those who do so fail to blame their poor results on defects in

the method. Lister himself refers very pointedly to this difficulty in speaking of the antiseptic system.

Lister says—"The antiseptic system does not owe its efficiency to any such cause, nor can it be taught by any rule of thumb. One rule, indeed, there is universal application of,—namely this: whatever be the antiseptic means employed (and they may be very various) use them so as to render impossible the existence of a living septic organism in the part concerned. But the carrying out of this rule implies a conviction of the truth of the germ theory of putrefaction, which, unfortunately, is in this country the subject of doubts such as I confess, surprise me, considering the character of the evidence which has been adduced in support of it. Yet, without this guiding principle, many parts of the treatment would be unmeaning; and the surgeon, even if he should attempt the servile imitation of a practice which he did not understand, would be constantly liable to deviate from the proper course in some apparently trivial but essential detail, and then, ignorant of his own mistake, would attribute the bad result to imperfection of the method. For my own part, I find that, in order to approach more and more to uniform success, it is necessary to act even more strictly in accordance with the dictates of the germ theory. Failure on the part of those who doubt or disbelieve it, is therefore only what I should expect."

Similar comments might be made with reference to failure to obtain satisfactory results from splinting. Very little so called splinting gives anything like true immobilization. Even when plaster-of-Paris (the ideal splint material) is employed, good immobilization is by no means always or even usually obtained.

The method of treatment by drainage and rest advocated by the writer rests upon the suitable combination and employment of a few details of technique all of which rest upon unquestioned fundamental truths of surgical practice. Any failure to comply with these principles will place the patient in jeopardy. A careful regard for the principles of drainage, antisepsis, and rest, however, even if other details of technique are employed, will usually lead to satisfactory results.

The therapeutic scheme proposed has yielded far better results in acute osteomyelitis than methods previously taught, and previously employed by the author in his own practice; moreover the results are better than in similar cases observed by him treated elsewhere by other methods. It is firmly believed that lives and limbs may be saved by this method and that suffering for the patients, labor for the surgeon and materials for the hospital may all be reduced.

## REPORT OF AN ILLUSTRATIVE CASE

No. 7005, aged six years.

This child came two hundred and fifty miles on the train and was admitted to the hospital September 1, 1926, with a temperature of 105 degrees, pulse 140, respiration 32, white blood count 28,000. There had been pain in the left knee and thigh for three days previously. Hot packs had been used to allay the discomfort but during the last twenty-four hours the least movement of the left lower extremity caused severe pain. The

temperature taken twelve hours before admission to the hospital was 106 degrees and had been 104 degrees on the previous day.

The lower third of the thigh was swollen and tender. There was a definite redness radiating to the outer side of the front lower portion of the thigh. Movement of the knee or hip caused severe pain. The child was negative as to other physical findings except for a mild furunculosis on the back of the neck and an infection of one finger. X-ray findings were negative as to any bone lesion.

The child was taken to the operating room with a diagnosis of acute osteomyelitis of the lower third of the femur. The operation was done by the author and his associate, Dr. Thomson. An incision was made laterally just behind the quadriceps group about six inches long. The skin, muscles and periosteum were reflected in one mass and a small chisel hole made in the cortex of the metaphysis just proximal to the epiphyseal line. Immediately a yellow, creamy pus welled out. The opening in the bone was extended toward the diaphysis to about three inches long and one-half inch wide so that the entire lower third of the femur was well drained.

Pus exuded freely and was apparently under pressure. Very little exploration of the medullary cavity was done and the wound was filled to the depth of the medulla with a vaselin gauze pack and vaselin covering placed over the entire area. A double plaster-of-Paris spica cast was applied. In twelve hours his temperature had dropped to 99 degrees; it went up in the afternoon to 101 degrees, but was down in the morning. The temperature ranged within these limits for three days; after which it remained under 99.6 for four days. After this he had a normal temperature, once or twice rising to 99.

At the end of six weeks the cast was removed and the dressings taken out. There had been considerable drainage under the cast, but removal of the vaselin pack showed the wound had filled in to practically one half the previous depth and was covered from the base with healthy granulation. A new single spica cast was put on and worn for a month longer, when it was removed and the wound was found to be healed, with the dressings pushed entirely out of the wound and the serum which had come from the wound entirely dried.

This wound which had gaped open originally about two inches, closed to less than one-half inch at the widest portion of the scar. He was placed in a caliper brace and physiotherapy, massage, and active and passive motion instituted. Since he has been up and around he has had no temperature and on January 10, 1927, was apparently entirely well.

## DISCUSSION

Dr. Ellis Jones, Los Angeles, Calif.: I am extremely grateful to Dr. Orr for introducing to me his method of treatment of chronic osteomyelitis six years ago. My enthusiasm for that method, however, did not give me sufficient courage to attempt his treatment of *acute* osteomyelitis until this last year. I have had experience in only two cases, one a child of nine years sent in on the third day. That child had three dressings in nine weeks. The other child, aged nine years, had five dressings in eleven weeks. I confess to many timorous moments. The temptation on the third and fourth days to remove the dressings was tremendous. I know of no other method by which such end results could have been obtained.

Infrequent dressings spare the patient and the surgeon. It is a tremendous temptation to examine the wound at frequent intervals. We should, however, remember that the exudate is pre-formed connective tissue and that we should permit that exudate to form new tissue, undisturbed by repeated dressings. Multiple dressings are traumatic, no matter how carefully the dressings are done. I am sorry that my experience has been such a limited one, but I am tremendously encouraged by even such a limited experience.

Dr. F. J. Gaenslen, Milwaukee, Wis.: I have heard Dr. Orr's method of treating osteomyelitis condemned by a good many during the past few years as being unscientific.

When I first heard of it in 1922 I condemned it on the same grounds. I felt that it violated a principle of surgery which I had always tried to comply with, namely to provide adequate drainage in case of infection. I felt that the vaselin pack as recommended prevented adequate drainage and I did not use it.

A year later I had a chance to discuss the method with Dr. Orr and to learn of his uniformly good results. Knowing him as I do, I felt I could take his statements at face value and therefore gave the method a trial at the first opportunity. Since then, in 1923, I have operated on sixteen private cases and twenty-four cases at the University Hospital at Madison. Some of these were multiple so there were really more than forty altogether. I have had no deaths and my results were so satisfactory that I have not considered any other method since that time.

I have here a summary of my forty cases which shows that in many of these the hospital stay was under one week, and that complete healing after radical operation resulted after two, or three, or sometimes four plaster casts put on at intervals of two or three weeks, the patients being brought into the hospital only for renewal of cast and immediately discharged. No windows were cut in the cast for dressings during the interval between cast changes and as a rule the patients were not seen except at time of change of cast.

I feel that when results such as these can be shown, it is *science* which lags behind in the explanation of demonstrated facts and that we must endeavor to advance this to meet the situation.

The essentials of the treatment are:

First: adequate drainage without suture. There are no objections to this.

Second: less antiseptics. I use antiseptics in these wounds occasionally to ease the conscience of assistants who feel that swabbing with iodin is of advantage. I have not used it in over half the cases and feel that it is unnecessary.

Third: the vaselin pack. Objections raised are that it may dam up secretions. I believe on the contrary that the vaselin mass is an excellent drain. It is a large, more or less conical, mass which recedes and is extruded only as the granulation tissue gradually fills in the wound. What secretion there is finds its way out readily between the wound walls and the vaselin mass. Redness and pain suggesting a cellulitis from retained secretion is uniformly absent.

Fourth: absolute immobilization. I think this is extremely important. If we could study the wound repair daily with the microscope I think it would be extremely interesting. No matter how carefully you carry out your dressings you will interrupt the repair processes nature is making.

There is one other point which I believe is important and that is one suggested in an article by Dr. Vilray P. Blair of St. Louis. In closing defects of the floor of the mouth he used skin grafts placed over previously prepared paraffin molds. These molds were then introduced into the mouth so that the defects were accurately covered with the grafts. In spite of the infection which the mouth constantly harbors, his results were excellent, and this Blair attributed to the beneficial effect of the pressure of the paraffin mold. He feels that pressure has never been given sufficient consideration as a factor of importance in wound healing.

It seems to me that in this method of Dr. Orr, the beneficial effects must also be attributed in considerable measure to the element of pressure of the vaselin mass filling the wound. This pressure approximates normal intracellular pressure under which growth and repair processes must be best served. In a wound without adequate surface pressure the superficial cells are apt to be more or less water-logged from reduction of surface tension. As a result the normal cell physiology is disturbed and the defense of the cell to infection is impaired and the process of repair greatly delayed.

The offensive odor, of course, is an objection, but one which my patients have been only too glad to put up with, when rapid and steady progress is made in a condition so serious as an osteomyelitis.

I feel that Dr. Orr has made a very wonderful contribution in the treatment of

chronic as well as of acute osteomyelitis. I feel that I can recommend the method on a basis of a fairly large and to me a very satisfactory experience.

Dr. Kleinberg has asked me to say that he has used this method in nine cases and that his results make him a warm advocate of the method.

Dr. M. S. Henderson, Rochester, Minn.: Dr. Orr has given us and has repeatedly emphasized in the last few years a sound surgical principle in the treatment of osteomyelitis. When he first talked to me about it, I was very skeptical, but I finally tried it out and was surprised how well these cases did. The objections to it are few, the chief one is the odor that comes from not changing the dressings and sometimes this is seriously inconvenient. However, the good points far out-rank the bad ones and this method has enabled us oftentimes to send patients home, if they live within a moderate distance, and when they return a month or two later we often find the sinuses healed. I think that if you try this method of Dr. Orr conscientiously, it will be of distinct advantage in many cases.

Dr. H. W. Orr, Lincoln, Neb. (Closing the discussion): I have already heard all of the objections to my method that have been mentioned here and a good many more. There are always many questions asked. Here is one that has just been sent up to me in the form of a note regarding the danger of sequestrum formation in these cases. It is my opinion that sequestrum formation depends upon whether or not an early efficient operation has been done. We have all been taught that at least in some cases it is better to wait until an osteomyelitis becomes chronic and until there has been extensive formation of involucrum before we undertake to do radical drainage. In such cases the sequestrum is a necessary feature of the case. If good drainage is done during the first few days, however, it is my experience there will be no death of bone and consequently no formation of sequestrum. If we wait for the formation of involucrum, we wait too long. If we relieve the condition at once by drainage, a sequestrum will not form, because there is not the extensive infection and death of bone.

With regard to the application of plaster-of-Paris in these cases, there is no objection to it whatever, if you follow the suggestions made with regard to the matter of drainage. I have shown that frequent dressings are not necessary, and that if frequent dressings are not done we do not have much discharge. Moreover, with the excellent immobilization that one gets in a double spica, another irritating factor is removed and dressings are not necessary. I consider that good immobilization in a double plaster-of-Paris spica is necessary and helpful in the cure of these cases.

I regret very much that Dr. Starr is not here, I am sure he could add many interesting and useful comments to the discussion.

With regard to this method of treating open wounds the important point is that we must avoid covering up the pockets of infection. If the wound heals from the bottom all the way up, such pockets do not form and complete and final healing is the result.

# RECURRENT MULTIPLE OSTEOMYELITIS DUE TO STAPHYLOCOCCUS AUREUS*

BY R. McE. SCHAUFFLER, M.D., KANSAS CITY, MO.

The purpose of this paper is to describe a type of osteomyelitis of which a sufficient number of cases have been observed to indicate that they present a clinical entity.

The disease usually begins in an acute form in childhood and has numerous remissions and exacerbations. The patients seldom die and it seems in many cases that they will never get well. The disease may last from early or middle childhood to late adolescence and one case was observed which had a duration of fifty years.

It is often labelled bone syphilis and sometimes multiple tuberculosis. It is caused by a staphylococcus aureus with a predilection for bone and deep fascia.

The distribution of the severe type is usually as follows: one or both femora with involvement of one hip, two or more lesions of humeri or tibiae and one or two other bone lesions.

Several severe lesions appear in rapid succession and the remaining major lesions in the course of the first year or two. These are accompanied by or followed by bone lesions of a periosteal type and lesions of deep fascia. Later lesions often are negative to x-ray and some deep-seated; painful swellings resolve, while others make abscesses which heal promptly after spontaneous or surgical evacuation.

Lesions of the humerus cure themselves by sequestration with or without surgical assistance. The same is true of the central and lower shaft of the tibia and the forearm bones. Major lesions of the shaft of the femur form massive sequestra, cured by operation at the time of election. The upper tibia has little tendency to gross sequestration. The involvement of the upper extremity of the femur usually leads to involvement of the hip. Of the seven cases reported here as the severe type three had pathological dislocation of the hip, two severe ankylosis, one medium and one slight impairment of hip function.

The cancellous bone of the upper tibia or upper femur usually constitutes the long persistent focus of infection from which the later periosteal and deep fascial infections have their origin.

Even in the worst cases there was usually only one bone with a central sequestrum and there were marginal sequestra of other bones where a part of the shaft was separated, without its being covered by an involucrum.

Some periosteal lesions evident in the x-rays heal without sinus formation.

*Read before the Annual Meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

In a somewhat less severe type there will be one or more of the major bone lesions noted above and a very long series of periosteal or deep fascia lesions. The patient, in the course of three or four years, may have twenty to forty such lesions, some of which resolve and others point. Often the patient seems to know which they will do and directs his treatment accordingly.

The specificity of these types was established by cutting down on deep-seated lesions in a part of the body where there had been no sinus and obtaining pure cultures of staphylococcus aureus. By the time a deep abscess has pointed the pus is usually sterile although in some cases subculture finally showed a pure growth of the organism.

There are milder cases in which the number of lesions is small, but recurrence and chronicity are striking features. The same organism has been found here, but with far less constancy.

The records of eighty-five consecutive cases of osteomyelitis, most of them from the Surgical or Orthopaedic Divisions of the Children's Mercy Hospital, were examined. They were from the service of Dr. J. G. Montgomery, Dr. C. B. Francisco or the author. Sixty presented single lesions, or, if there was more than one, the extension seemed to have been by contiguity. Five presented syphilitic lesions of such magnitude as to have been admitted for surgical treatment. No account was taken of bone lesions remaining on the division of congenital syphilis. There remained twenty cases of multiple osteomyelitis which form the basis of this paper. Seven were of the severe type with wide-spread lesions and many abscesses. Thirteen had two or more widely separated bone lesions and were characterized by chronicity and recurrence with occasionally a periosteal or fascial abscess. Of the seven cases of the first type, five showed only staphylococcus aureus in pure cultures from lesions surgically exposed. One was reported pneumococcus. The case of the man fifty-six years old, put in to illustrate extreme chronicity, had no cultures made. Of the thirteen cases of the second type, four showed pure staphylococcus aureus, three pure staphylococcus albus and in six there was either no growth or a multiplicity of organisms from sinus contamination. Not many blood cultures were made and in only one case was the staphylococcus found in the blood.

### SEVERE TYPE, SEVEN CASES

CASE 1. Boy, fourteen years old on admission. Onset fourteen months before in right humerus, late sinus formation. Left hip contracture and pain six months after onset, sinus three months later. Abscess of forearm sometime during first year. On admission healed sinus lower right humerus, sinuses upper right humerus, left hip, healed sinus over ulna. X-rays showed pathological fracture of the upper humerus, united with some deformity. Slight bone involvement of neck of femur, some changes articular surfaces, massive periosteal thickening of ulna. The latter lesion looked strongly luetic. *Diagnosis:* congenital syphilis perhaps with tuberculosis also. Patient in the hospital twenty-six months. Small sequestrum extruded from upper right humerus, small superficial sequestrum from left humerus; four or five scattered abscesses, ankylosis left hip, new involvement lower left humerus. Thirteen months after admission

a new periosteal involvement of upper right femur in a region never before affected was cut down on. Cultures showed pure staphylococcus aureus.

In the last year in the hospital there was new involvement of upper left humerus with large sequestrum and a deep abscess of the forearm, both showing the same organism. Heliotherapy was continued and an autogenous vaccine used. The boy looked well and was doing some volunteer orderly work.

He was transferred to Research Hospital in the fortieth month of his illness. In the next two months a new abscess developed near original sinus of left hip, the second bone involved, and a forearm abscess with negative x-ray; same organism. Discharged with sinuses all healed or nearly so except left hip region from which there was considerable discharge. X-rays of this ankylosed hip and adjacent femur were confusing and gave no clear indication of site of disease.

The patient did fairly well for a few months after return to Arkansas, then developed more abscesses and a terminal nephritis and died of uraemia. Total duration of illness, four years.

From later experience the author is convinced that the persistent focus for infections was in the cancellous bone of the upper extremity of the left femur.

Case 2. Boy, twelve and one-half years old at onset, which was sudden in region of left knee, abscess over upper tibia on ninth day, some dead bone removed three months later.

Admitted to hospital at age of fourteen, sinus over left tibia. X-rays showed erosive changes in upper third of tibia, no sequestra, some erosion of joint surface. Lungs showed some residue of an infectious process of upper right lobe. Diagnosis; tuberculosis. In the next eighteen months there was destructive bone involvement of the neck of the right femur, with flexion contracture of the hip, and of the upper right humerus. There were abscesses explored over upper right femur and clavicle, without finding bone involvement. There were many indurated areas, some of which resolved and some made abscesses. At first he averaged one every three weeks, after a year one every three months.

The tibia was cleared up by operation early in his stay. At the end of one and one-half years a small sequestrum was removed from right trochanteric region and a softened area cleaned out. He was apparently well six months afterward, when he disappeared from observation. This boy was not on the writer's service. The record shows only one culture, which was made from a newly opened abscess over the clavicle and was reported pneumococcus.

Case 3. Boy, six years old at onset, in upper left femur. Eight weeks later, abscess of lower left humerus. Admitted at age of seven. Pathological dislocation of left hip, central sequestrum almost entire shaft of left femur. Spongy osteomyelitis, lower half left humerus. Recent periosteal lesion, upper shaft of right humerus with sinus. History of three scattered abscesses. Died of postoperative shock from sequestrotomy of femur.

Case 4. Boy, nine years old at onset in upper right tibia, early followed by upper left femur and hip. Sinuses never healed. Right ilium, healed. Admitted at age of twelve. Involvement of both tibiae, upper half left femur with large sequestrum of shaft and pathological dislocation of hip, left humerus, many scars of healed sinuses. Soon after admission he developed a deep abscess over shaft of right femur with negative x-ray. Two months of heliotherapy and high caloric diet, then sequestrotomy of femur. Much improvement and several sinuses healed, but he had four new abscesses in next six months.

X-ray showed mottling of upper left tibia and, although there was no sinus open, this was explored. Under an irregular, thin outer shell there was much soft bone and granulation pockets with very tiny sequestra. A vaselin pack was inserted and plaster

cast applied. This was healed in four months and there was only one sinus with little discharge in left trochanteric region. On the sixteenth month after admission he had another distant abscess. A rarefied area in the trochanteric region was explored and excised. Twenty months after admission and fifty-six months after onset he seems well and has been discharged, but is remaining under observation.

CASE 5. Girl, aged twelve. Acute onset, lower left tibia, first subperiosteal, later osteomyelitis, pathological fracture. Both iliac bones, both hip joints, duration fourteen months. Sequestrotomy tibia and right ilium. Recovery, severe fibrous ankylosis right hip, slight of left hip.

CASE 6. Boy, aged fifteen. Extensive osteomyelitis of lower half left femur and of right ilium with bone softening. Slight bone changes in right hip. Duration eleven months, cured by radical operations. Some fibrous ankylosis hip.

CASE 7. Man, aged fifty-six. At age six "bone rheumatism" began. Right tibia first affected, abscess opened; then left hip, both upper arms and side of neck, discharge from all these regions; later left tibia, one metacarpal. Had a succession of these attacks and scattered abscesses diminishing in frequency from the age of six to twenty-five years. No trouble above knees in next thirty years, but intermittently had small sinuses or ulcers on one upper tibia or the other. One year ago chronic slowly spreading ulcer in site of earlier ulcers over right tibia, now has offensive odor. Examination shows pathological dislocation left hip and scars corresponding to report of sites of abscesses and an epithelioma of the right tibial region.

There were thirteen cases of the milder type. Some of the bone lesions were extensive and destructive. There were only occasionally periosteal or fascial lesions. A few were probably stopped early by efficient operation, but they did not have the tendency to a large number of lesions so characteristic of the first group.

The distribution of lesions and the duration were as follows:

CASE 8. Boy, aged twelve. Left tibia, slight lesion, early abscess; lower right femur, onset two weeks later, extensive osteomyelitis, pathological fracture. Right os calcis, left metatarsal, pathological fracture. Duration nine and one-half months. Recovery with shortening and loss of much of os calcis.

CASE 9. Girl, aged six. Right upper tibia. Inadequate operation two months from onset. Shaft right femur, little bone change. Ten months from onset, right hip sinus. One year later, pocket in great trochanter cleaned out. Three years from onset, abscess over right humerus. X-ray showed periosteal thickening, no sequestrum. Late exploration of sinus, no bone lesion. Clean-up of upper tibia. Three and one-half years from onset, apparently cured with considerable stiffness of hip.

CASE 10. Boy, aged eight. Right humerus, moderate osteomyelitis. Two months later, abscess over left clavicle; operation disclosed no bone lesion. Duration four months. Recovery.

CASE 11. Boy, aged eleven. Left os calcis extensive osteomyelitis, right clavicle periosteal abscess. Duration five months. Recovery with much loss of os calcis.

CASE 12. Boy, aged fourteen. Onset six months before admission. Softening and abscess of cancellous bone upper left tibia. Right tibia, small sequestrum shaft. Right ulna, marked periosteal thickening. Slight changes upper right humerus. Removed from hospital in one month against advice.

CASE 13. Girl, aged nine. Onset pain and swelling left ankle. X-ray negative, called arthritic. One month later large deep abscess upper left thigh. X-ray negative, healed promptly, ankle seemed better. Ten months later returned with pain in left ankle. X-ray showed central abscess in cancellous bone close to epiphyseal line. Operation. Cure.

CASE 14. Boy, aged fourteen. Extensive osteomyelitis lower femur, perforation

of knee before admission. Several scattered deep fascia abscesses. X-rays negative.

CASE 15. Reported in detail in text.

CASE 16. Girl, aged thirteen. Seven years before admission pain and swelling, left ankle. No abscess, no operation. Three months later pain and swelling left hip region. Abscesses opened, some bone removal. Pathological dislocation of hip. Last sinus healed six months before present trouble began. Six weeks ago began to have pain and swelling in region of left ankle. X-ray showed large central abscess in cancellous bone of lower tibia close to epiphyseal line. Operation. Culture, pure staphylococcus albus. Vaselin pack. Healed in three months. Apparently well three months later.

CASE 17. Boy, aged seven. Acute onset pain upper tibia, one week. Later abscess over ulna which discharged. One abscess deep fascia thigh. Exploration of tibia showed abscess in cancellous bone, culture pure staphylococcus aureus. No further lesions. Wound healed and apparently well four months later.

CASE 18. Girl, aged eleven. Onset one year before admission. Began in lower tibia. On admission both lower tibiae showed osteomyelitis without gross sequestra. Partial ankylosis left hip. Extensive destruction of bone in pelvis about left sacro-iliac joint. Multiple stones in each kidney. Still in hospital two years later, one tibia cleaned up, one improved. To have another operation on sacro-iliac region. Seems much improved, but prognosis grave.

CASE 19. Reported in text.

CASE 20. Boy, aged two, large furuncle of thigh, two large and one small scattered abscesses of deep fascia in next three weeks; onset of disease of left hip about fourth week. Pathological dislocation of hip sometime in next two months. Admitted to hospital with small hip sinus. Apparently cured by heliotherapy in six months.

One of the reasons for reporting these cases is that even in our hospital some of the earlier cases were carried for a long time under a diagnosis of congenital syphilis and given much anti-luetic treatment. Others were considered tuberculosis or both syphilis and tuberculosis. The diagnoses were concurred in by the best local authority on congenital syphilis and an experienced orthopaedic surgeon. The x-rays of some of the lesions strongly supported such a presumption. However, it seemed to the writer that the whole clinical picture and the failure of medication to effect a cure was enough to discredit the diagnosis.

Two recent minor cases illustrate this error, as well as some of the earlier major ones.

CASE 15. Boy, five and one-half years old. June, 1926, severe pain in right leg after swimming. Three days later an abscess was opened on the upper tibia. It healed in three weeks. Soon afterward an abscess was opened over the upper part of the shaft of the right femur. There is the scar of a long incision. The mother reports that the doctor found no diseased bone. About the same time an abscess formed over the left radius in the lower forearm, discharged itself and healed. In December, 1926, a sluggish abscess near the left wrist was aspirated, examined for tuberculosis and a guinea pig inoculated, with negative results. The left tibia was somewhat painful and tender. The x-rays showed some changes near the head and some periosteal thickening a little lower down. His Wassermann was one plus, one plus. He was seized on as a case of congenital syphilis and given vigorous treatment.

April 1, 1927, his tibia was more tender and an osteomyelitis was diagnosed by another doctor. He was admitted on the author's service. Operation on the upper tibia showed quite extensive disease of the cancellous bone. The first cultures were reported negative, subcultures on agar brain broth, plain broth and blood agar each showed a luxurious growth of staphylococcus albus. The boy is now apparently well.

Case 19 is another illustration in point.

CASE 19. First seen by the author as a girl at age of ten with a chronic arthritis of the knee, with some suspicious appearances in the bone. Case was treated as a tubercular knee for a year and the diagnosis then abandoned on the clinical course and syphilis suspected. Her Wassermann was negative, but her father had a history of syphilis. After another year she disappeared from notice.

At the age of twenty she returned with a painful lump over upper fibula. X-ray showed slight periosteal thickening. Later on, an abscess opened and a small scale of dead bone was discharged. The knee seemed normal, lower femur somewhat thickened.

A year later she appeared with a painful mass over the internal condyle and was immediately ordered to the hospital for exploratory operation. She delayed a week and by that time resolution was progressing and nothing was done. The girl had married into a doctor's family. Her father-in-law considered she must have congenital syphilis and he was supported by one of our best internists, despite a negative Wassermann. She was treated accordingly. The situation was an unhappy one for all concerned.

She was directed to come to the author the moment she had another tender swelling. This she did very recently. The swelling was aspirated. The pathologist predicted tuberculosis, made his smears and cultures and inoculated a pig. Smears were negative, first culture negative, subculture pure staphylococcus aureus. A new x-ray showed a small osteomyelitic area in the cancellous bone of the lower end of the femur, with evidence of thickening and regenerative changes of long standing. The stigma of syphilis is definitely removed. The case can be cured by operation on the focus in the lower femur.

*Treatment:* Most of the severe cases had a long course of heliotherapy This greatly improved their general condition, but failed to cure them. The gross sequestra were removed in all cases. It was necessary to delay a little sometimes to improve the general condition and to do the operations in instalments. Particularly in the femur it is necessary to remove the sequestrum with the minimum of trauma. An ideal operation for osteomyelitis, with such removal of the involucrum as to make possible the insertion of a flap into the cavity, exposes these patients to the hazard of dangerous postoperative shock.

Some of the patients received an autogenous vaccine. This seemed to help, but did not cure. It should be reserved for the final clean-up after surgery has done its best. The all-important indication is to search for and clean up the quiet foci in the cancellous bone, most often in the upper tibiae, next in the femur. The natural tendency is to remove sequestra, provide good drainage and give a long course of heliotherapy and ultra-violet. The patients gain weight, look and feel well, but go on with a series of abscesses. Most of these are scattered lesions of periosteum or deep fascia, and heal promptly. From time to time a sinus over one of the chronic foci reopens or a small new abscess forms nearby. This fact, with careful study of the x-rays, which are masked by the old reparative processes, leads one to the point of attack.

It is hard to be persistent. The patients have been very sick and now feel well. They have perhaps had three or four operations before they came to you and a number more while under your care. They have been in the hospital a year or longer. They do not want another operation. If you still retain any suspicion that the trouble is tubercular or syphilitic

you are lost. If you have confidence in your diagnosis and are both fortunate and skillful in your final attack on the foci near the joint ends, the patient is cured.

Dr. Starr and his associates in Toronto have taught us to look first at the cancellous bone for the onset of an osteomyelitis and the opportunity of quickly ending the disease. In these unfortunate chronic cases of multiple osteomyelitis, the author urges you to look again in the cancellous bone for the last hope for a cure.

## DISCUSSION

Dr. W. E. Blodgett, Detroit, Mich.: I enjoyed reading this paper and I enjoyed hearing it now. It seemed to duplicate our work and I cannot find I am in any way out of agreement with the speaker. Perhaps two cases from our work will illustrate the outstanding features of Dr. Schauffler's paper.

The first case is a serious involvement of the femur with multiple abscesses. These abscesses have appeared in the periosteum and in the skin above these areas. There have been perhaps twenty of them. Some of them would heal without interference with simply latent heat. Others would heal with drainage but they continue to come. The patient has been under our care now for fully a year. He came to us two years after the original involvement of the femur. In order to remove the focus we have done two operations on the femur, both of them were necessarily incomplete because of the condition of the patient. The first operation resulted in a serious shock which prevented our continuing the operation. At the second operation we endeavored to take out the diseased part of the femur but found it was so extensive that we feared a repetition of the severe shock of the first operation and we desisted. It hardly seems as if this patient could survive his condition but he still lives on. I would like to ask Dr. Schauffler if he would advise complete removal of the shaft of the femur as the only escape from a lingering death.

The other patient represents an opportunity to do a radical operation successfully. It was an involvement of the lower end of the fibula. By the Orr method the original focus was healed in about six weeks. The skin abscesses which were just appearing before the operation are still draining. Characteristic of these fascial abscesses is the wide extent of the abscess in spite of the small involvement of the surface. One abscess is located on the opposite femur and the other on the upper arm opposite from the focus of infection. In each case the outstanding feature was that a blunt instrument could be introduced between the skin and the fascia to the extent of perhaps six inches in every direction from the center of the abscess, although the skin involvement was only two inches.

Dr. J. S. Speed, Memphis, Tenn.: I must say that Dr. Schauffler's paper has given me some new ideas. I cannot say that I have been thoroughly able to change my conception of osteomyelitis, particularly acute osteomyelitis, to conform to Dr. Schauffler's ideas as to the etiology or origin of these secondary lesions of which he speaks. It has been and still is my conception of osteomyelitis that originally it is a bacterium, that there is a shower of organisms into the blood stream. Unfortunately we have not cultured all of the osteomyelitis cases and possibly with persistent culture you could easily detect staphylococcus aureus in the blood stream. Granted there is a bacterium and we have a shower of infected emboli, we have a limited area which lies just at the diaphysis which is particularly susceptible to those bacteria. I hesitate to disagree, but I think a difference of opinion is the only stimulation we have. I cannot help but think that the seeds of these secondary lesions are implanted at the original acute infection. We know when the bacteria reach these secondary foci they can be forced one of three ways: an acute focus with destruction of bone, a subacute focus with

some pus around it, or a complete restoration which leaves no footprints on the bone. Consequently, I feel that these secondary lesions are in all probability the seeds that are sown at the original infection. We have had x-rays to show an old bone lesion which is repaired to a great extent and which flared up and required treatment twenty-five years after infection. Most lesions which we have give us enough trouble to require treatment in the early part of the disease.

Fascial lesions are new to me. If we accept the theory that a chronic focus is a latent secondary focus, then the lesion can occur in the fascia as well as in the bone. I feel that any accumulation of pus in a limb which was originally due to osteomyelitis, was due to some abscess lower down which we are not able to see.

I think Dr. Schauffler's ideas are very stimulating and while I say I cannot accept them, by disagreeing I may get some further points on the subject. I certainly thank him very much for his paper.

Dr. Robert McE. Schauffler, Kansas City, Mo. (Closing the discussion): I cannot prescribe for Dr. Blodgett's patient. It may be that the leg will have to come off. Usually if these abscesses are drained and have some heliotherapy and vaccine, we can get them well enough to do an operation.

As to the shower of bacteria referred to by Dr. Speed, of course there is a shower of bacteria in the blood before an osteomyelitis. There probably was in the sixty cases of ordinary osteomyelitis which I did not describe. It comes from some superficial point of infection or from some local focus.

In those cases described there were repeated subshowers. Where did they come from? It is my contention that at least the later ones come from some focus of osteomyelitis in the cancellous bone. If we could catch the organisms in the blood on their moving day, we could attack them there. Unfortunately we seldom can catch them.

My first point is that there is a particular strain of staphylococcus aureus which has a prediliction for bone and deep fascia.

What is the source of these subshowers? That is the second point of this paper. I think they come from smouldering areas in the cancellous bone.

Certainly if we are to finish our job and cure these patients, we must find where they come from and get rid of them. That was the moral of the first case. I did not finish my job and the patient later died.

# A METHOD OF SPINAL FIXATION IN TUBERCULAR SPONDYLITIS IN CHILDREN

BY SAMUEL ASHBY GRANTHAM, M.D., JOPLIN, MO.

Much remains to be said concerning the treatment of tubercular spondylitis in children.

It would be disastrous if the profession were to accept the dictum of Dr. Allison in his article in *Surgery, Gynecology and Obstetrics* of June 1927, that "*The great catastrophe of surgical tuberculosis is surgical interference*, both in adults and in children"; that "The length of time required for cure is *not an argument to be used*"; that "Surgical interference is *dangerous at best* and leads to disaster in most instances"; endorsing as he does, the technique at Rollier's clinic of "periods of time ranging from two to ten years". Dr. Allison states, "The matter of resumption of function is decided by the roentgenologist who purposely has no clinical knowledge of the progress of the individual. When the x-ray plate shows . . . sufficient 'bloc' about diseased vertebrae, then it is decided that the patient may be up and about."

It seems apparent that any treatment must include the immediate fixation of the diseased area. If a method could be devised which would promptly and positively immobilize the vertebrae at the site of injury, without, at the same time, jeopardizing the life, comfort or security of the patient, it would be a decided step forward in the treatment of these little ones. Other measures, as posturing, braces, casts, heliotherapy (natural, artificial, or both) proper feeding, cheerful surroundings, etc., are simply accessory to the primary thought in the treatment. The " 'bloc' about the diseased vertebrae" is the important *desideratum*. *That* seems to be the condition for which the orthopaedic surgeon waits. If this can be secured in ten minutes, why wait *ten years?*

The most disastrous thing that can occur to a child is the necessity for confinement and idleness over a long period of time, interfering with the normal development of the child. No one will deny that a child that is able to be up and about, playing normally and happily in the sun, unhampered by apparatus or restraint, is in a more favorable condition for his development than one confined to a Bradford frame or lying on a cot housed with other tubercular children.

The profession is, as yet, pretty well united in the opinion that an adult spine that has been weakened by tuberculosis, should be operated on and positively fixed by some method which immediately gives support to the structures, preventing motion in the diseased area. It appears that the only reason that the same method has not been generally adopted with children, is the fact that the known methods of fixation, those of Dr. Albee and Dr. Hibbs, are not followed by results which justify them. Hibbs'

operation is a mutilating procedure, and surgeons hesitate at the performance of this operation on children. The technique of Dr. Albee's operation is much simpler for use with children and lends itself more readily to the mechanics of the situation, without great mutilation; but the difficulty with this method has been that in endeavoring to split the spinous processes, operators have failed to secure sufficient bony contact of the graft to the posterior processes; and the *dorsal fascia once split* seems to yield under the slightest pressure by the ends of the graft, permitting them to rise up into the thin scar in such manner as to necessitate their later trimming,—thus sacrificing the *supporting* influence of the implanted graft. It was due to this embarrassing circumstance that the ends of the graft were tucked under the *uncut fascia* at the upper and lower extremities of the wound, thus securing immediate mechanical support where most needed. The method developed within the last fifteen years very nearly meets the requirements, and so generally beneficial has this simple operation been, that it is well worth presenting again.

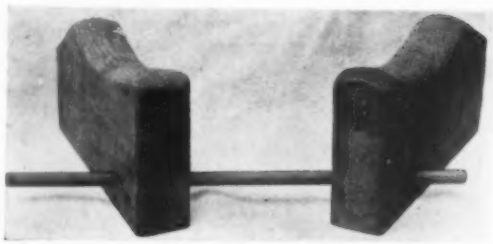

FIG. 1

Adjustable shoulder rest which fits any body. By its use the thorax is raised from the table, permitting thoracic breathing during operation on the back.

The patient is placed in the prone position, the shoulders elevated on a special shoulder rest which permits free thoracic breathing. The pelvis is placed on the kidney elevator found on the ordinary operating table. This position, supporting the torso in the air, enables the operator to secure as much straightening of a kyphosis as he deems safe. There is no question but that some correction can be secured by this means.

A transverse incision about one inch in length is made just below the posterior process of the second vertebra below the affected vertebra,

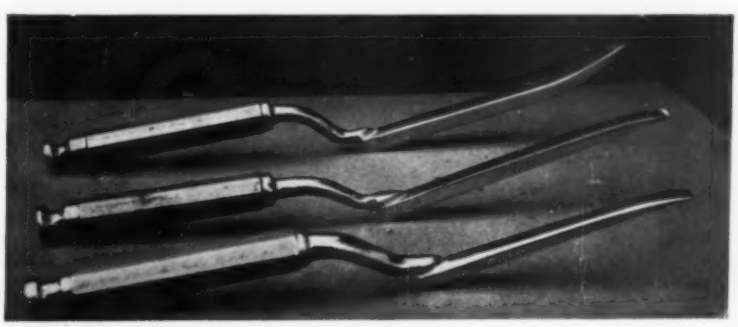

FIG. 2

Tunneling osteotome, showing trowel-like handle which enables operator to avoid skin contact while operating.

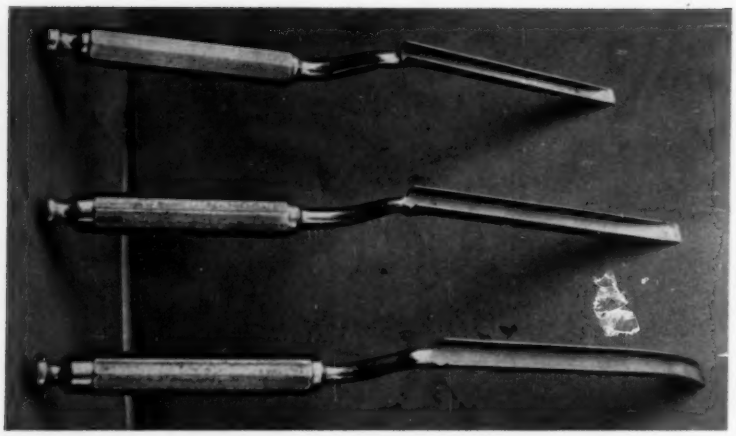

FIG. 3

Tunneling osteotome, showing rectangular groove on ventral surface of blade.

extending through the supraspinous ligament to a point just above the level of the lamina. A tunneling osteotome, or chisel, is introduced into the incision to a point on the posterior process just above the laminae and the first process sectioned. The blade of this osteotome is five and one-half inches in length, and is so constructed as to present, on its ventral surface, a rectangular groove five-sixteenths of an inch wide and one-fourth of an inch deep, running the entire length of the blade, with a handle bent in a reverse curve, like a trowel, to give room for the operator's knuckles without dragging upon the back. The blade of the osteotome is now made to assume the horizontal position and the posterior process of the next vertebra above sectioned at the same level, continuing the sectioning of the posterior processes until the second vertebra above the affected vertebra is reached. The tips of the sectioned processes rise on the inclined plane presented by the dorsal surface of the tunneling tool as it is advanced toward the next process to be cut. The osteotome remaining *in situ*, a tibial graft, as long as desired, which fits the groove in the instrument, is secured, inserted into the tunnel created by the blade of the osteotome, and pushed home. The osteotome is now withdrawn, leaving the graft firmly planted on the stumps of the sectioned posterior processes, the tips of the sectioned processes dropping firmly upon the dorsal surface of the graft. The closure of the incisions completes the operation. This operation is completed in from eight to fourteen minutes. The graft is so placed that it cannot shift from its position. The *uncut* dorsal fascia fits snugly over it; the muscles on each side of the posterior processes support it laterally. It is fixed. *No sutures or ligatures are necessary to hold it.* Simple dressings are applied and the patient put to bed, without restraining apparatus, on a flat mattress.

Not much need be said concerning the postoperative treatment. With the first patients operated on by the author according to this method,

FIG. 4

Case 1, N. K. Lateral view of spine, before operation, May 2, 1927.

he was extremely cautious in the matter of movement and posture, hoping by the supine position to secure further correction of kyphoses, and fearful lest something should happen to disturb the implanted graft. But it was found that the graft so implanted secured immediate extension of the kyphos and the patients soon took the affair into their own hands, sitting up in bed, rolling about, slipping out of bed to the nearest toilet, in fact, doing as they pleased, apparently without harm. The discipline has relaxed until at present the widest range of movement compatible with the comfort of the patient is permitted.

## CASE REPORTS

CASE 1. N. K., aged eight, applied for treatment May 2, 1927. Two years previous n a railroad accident, she had lost her right arm at the shoulder and hurt her back. Examination disclosed a kyphos in the lumbar region. Skiagraphs showed third and fourth lumbar vertebrae destroyed. Diagnosis was made of tubercular spondylitis of third and fourth lumbar vertebrae. History showed pain radiating along the right ilioinguinal, anterior crural and sciatic nerves; thigh slightly flexed, painful on extension; gait halting; walking painful; *recumbent position relieves pain;* patient whining and fretful on being forced to sit, stand, or walk; general appearance emaciated; underdeveloped. Spinal fixation was advised.

FIG. 5

Case 1, N. K. Before operation. Note slightly flexed right leg.

Operation was performed May 12, 1927. A five-inch tibial graft five-sixteenths of an inch wide, full thickness of the cortex of the tibia, was implanted through a *one-inch incision*, under the *uncut lumbar fascia*, snugly between the fragments of the sectioned posterior processes. The tunneling osteotome, by which the implantation was rendered easy, was then withdrawn and the wounds closed with a running subcuticular suture of 000 catgut. Operation was completed in twelve minutes.

When seen on the third postoperative day, the patient was sitting up in bed, curiously

FIG. 6

Case 1, N.K. One month after operation. Note straight right leg, standing at ease.

inspecting the bloodstained dressings on her shin. She had no pain and announced "I can straighten my leg out". She did not know she had a back and was surprised when her attention was called to the small patch of gauze in that region. Turning herself about in the bed, she permitted her legs to hang down and sat up beautifully erect. When she was lifted to the floor she stood with her heels together, erect, without pain. Unaided, she walked six feet, complaining of her shin which gave her some pain,—the only pain she has ever mentioned. She remained in the hospital four weeks, taking daily "rides" in a wheel-chair. She is now at home, playing in the sun with the chickens, and comes to the office twice weekly for artificial heliotherapy and *inspection*. Yesterday, the *sixth postoperative week*, she ran gleefully, trying to catch a robin on the lawn.

FIG. 7

Case 1, N. K. One month after operation. Attitude comfortable; no fat to hide the subfascial graft.

Play in the sun; cheerful wholesome surroundings; plenty of good wholesome food; plenty of refreshing sleep, "kind Nature's sweet restorer"; and *freedom from pain*, seem to be the conditions devoutly to be wished.

CASE 2. J. C., aged ten, was first seen by the author on May 31, 1926, giving history of having fallen on the rocks and hurt his back. Sometime later his mother noticed a "knot" in his back. Inspection disclosed a kyphos in the lumbar region. Skiagraphs showed the body of the third lumbar vertebra reduced to a wedge. Diagnosis: tubercular spondylitis involving the third lumbar vertebra. Pachymeningitis and pressure on spinal nerves near their exit from the spinal canal had rendered both legs useless with spastic paralysis. Patient could not walk. Spinal fixation was recommended and patient was operated upon June 5, 1926. Operation required twelve minutes.

This boy presented the usual course of uneventful recovery, but because of uncertainty as to his home surroundings, was kept in the hospital nine weeks. On leaving the hospital he was encased in a celluloid corset, and thoroughly warned as to the danger of falling and injuring his back. His legs improved promptly but he walked as though he were afraid. The removal of the corset seemed to set his spirit free. He moved with greater freedom and more perfect balance. He afterwards admitted that he had never been afraid of hurting his back, but he did not want to *"break my corset"*. On hearing a noise overhead, a short time ago, his mother stepped out into the yard to discover the cause, and found him *on top of the house*. He explained that it had become necessary for him to get up and get his kite. Apparently his recovery is complete.

CASE 3. J. F., aged seven, was first seen on July 26, 1926. Inspection revealed a pronounced gibbus in the upper thoracic region. A steel brace had been applied with an extension supporting his head; pachymeningitis and pressure rendered his legs useless for walking; mentally precocious. The history showed that at the age of two a kyphos had manifested itself in the upper thoracic region. This, in spite of the best advice, had become more pronounced; posturing on frames, sunlight, methodically and persistently carried out under the supervision of some of the finest paediatricians and orthopaedic surgeons in the best hospitals in Colorado and Missouri, all proved futile. During the five years of his invalidism he had grown progressively worse, until he had practically

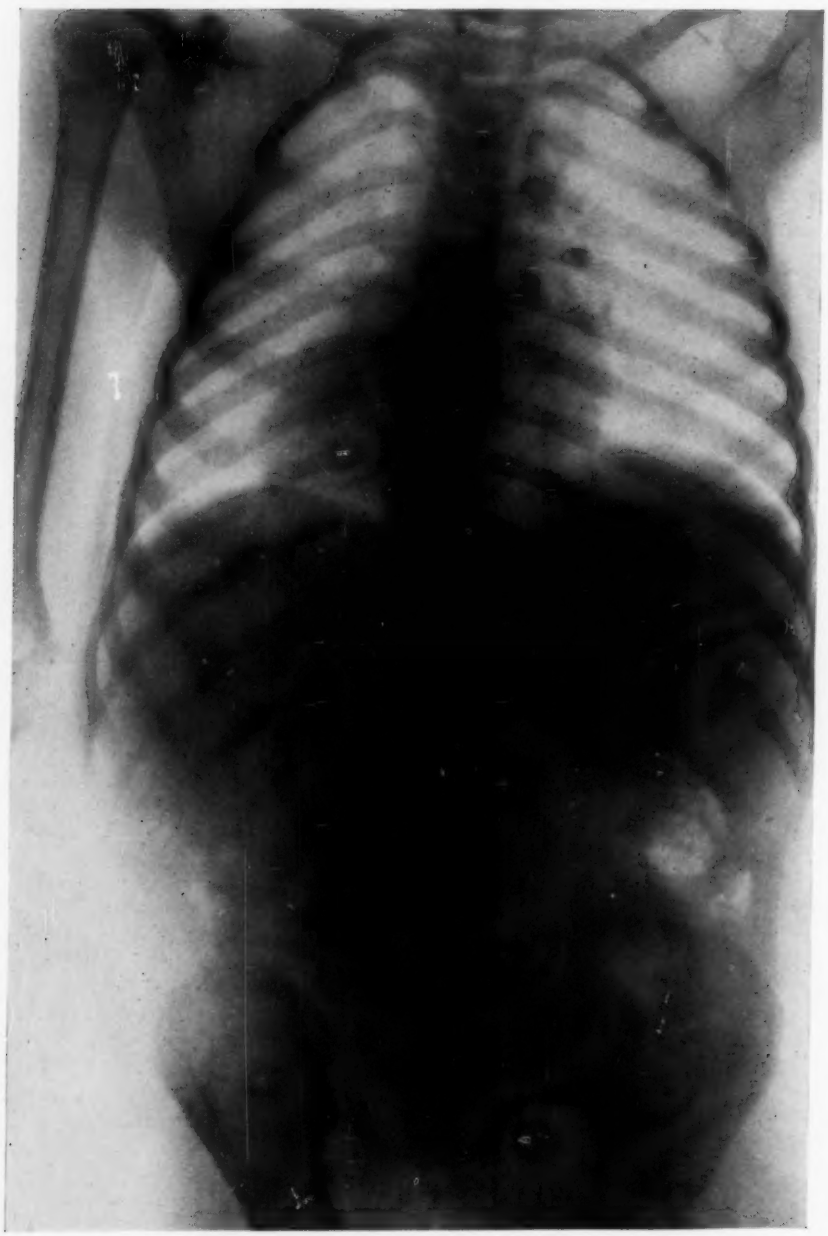

FIG. 8

Case 1, N. K. Showing back after operation, June 13, 1927.

FIG. 9

Case 2, J. C. Lateral view of spine nine months after operation.

FIG. 10

Case 2, J. C. One year after operation, standing at ease.

FIG. 11

Case 2, J. C. One year after operation, showing his muscle.

lost the use of his legs. Diagnosis: tuberculosis of the fifth, sixth and seventh dorsal vertebrae.

Operation was performed August 2, 1926. In this case the curvature was so acute that a straight tunneling instrument was ineffective and a straight tunnel from normal vertebrae below to normal vertebrae above, impracticable. The incision was made just below the high point of the kyphos extending through the supraspinous ligament, transversely for one inch. With a curved chisel, concavity downward, a tunnel was driven toward the head through the posterior processes, *under the dorsal fascia*, to a point where normal vertebrae were reached. The chisel was then withdrawn, entered through the same incision, directed downward in the same manner, and a tunnel driven until sound vertebrae below the affected area were reached. A section of the eighth rib, four and one-half inches long, was enucleated, bare of periosteum. Using the chisel as a grooved director the rib was inserted into the tunnel toward the head, the upper end

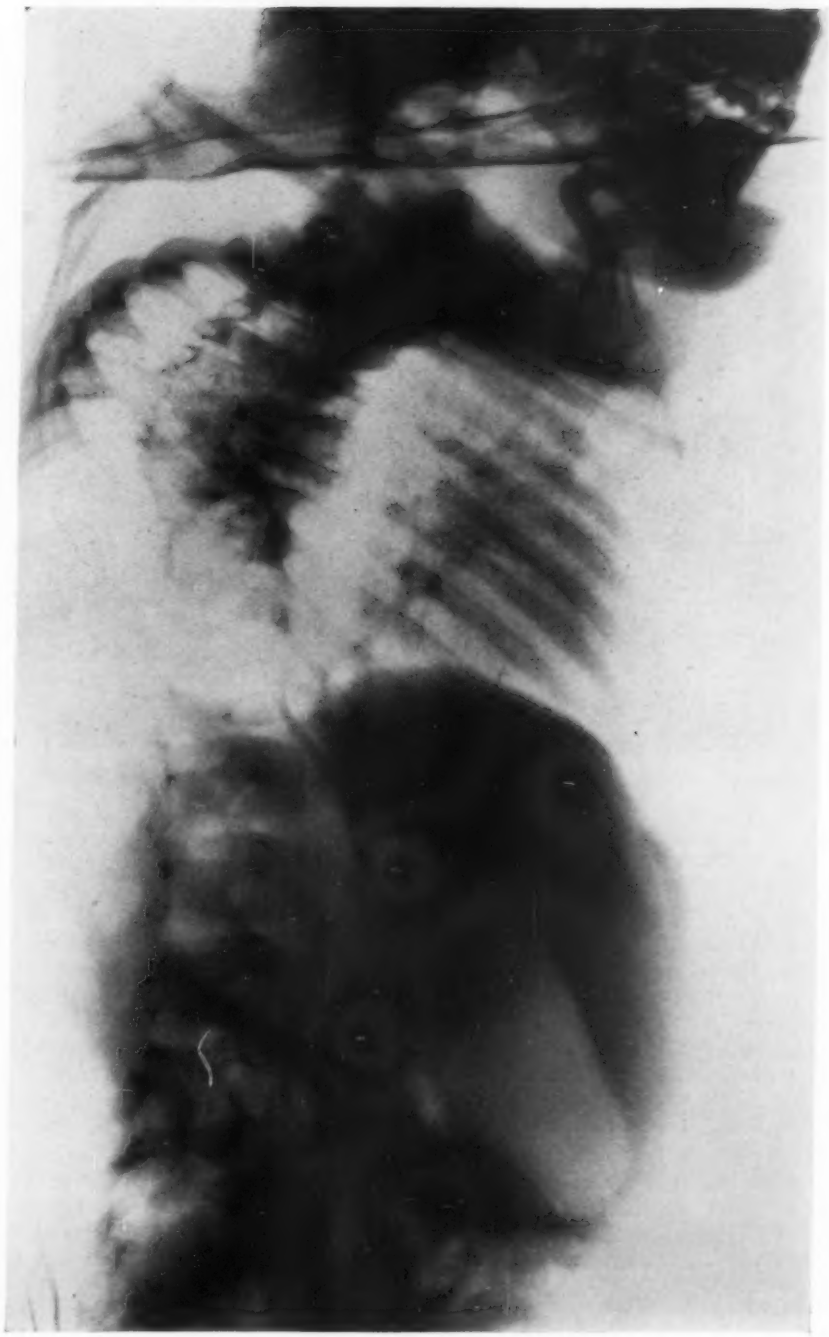

FIG. 12

Case 3, J. F. Lateral view before operation, July 26, 1926.

FIG. 13

Case 3, J. F. Age seven, before operation. Wearing a steel frame with a brace extended to support his head, legs helpless, unable to walk.

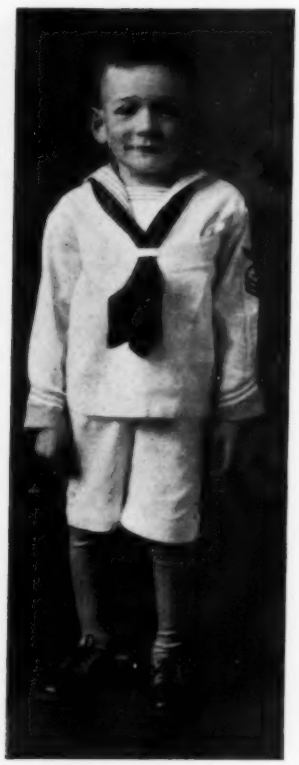

FIG. 14

Case 3, J. F. Four months after operation. Just returned from an excursion to St. Louis, window-shopping with his mother.

being forced to one side of the *uncut* process so that it could be slipped still further toward the neck under the muscles until the lower end of the graft could be entered into the incision. Then, again using the chisel as a guide, the lower extremity was backed down the tunnel until it was properly placed to give support to the weakened spine. The wounds were closed in the usual manner and the patient put to bed on his back with a small pillow under the kyphos. Operating time was eleven minutes.

So thoroughly trained were the parents of this young man in the *laissez faire* policy, that they succeeded in keeping him on his back on a frame for two months. Then insistent youth began to assert itself, his legs improved apace, all pain disappeared. His favorite mode of retiring at night became a high dive from his mother's bed into his own crib, landing on his head and neck,— some test of the security of the work! The photograph (Fig. 14) taken four months after operation tells the story,— a graphic refutation of the dictum, *"The great catastrophe of surgical tuberculosis is surgical interference"*!

Age has no bearing on the question as to when this operation is applicable.

CASE 4. I. F., aged two and one-half years, applied for treatment in August 1914. The history disclosed that at the age of one and one-half years, angulation in the upper thoracic region appeared. An early diagnosis seems to have been made of Pott's disease

FIG. 15

Case 4, I. F. Aged two and one-half years, before operation. Note the only position in which she was able to stand. Spasticity of legs prevented her walking. Child is crying with pain.

FIG. 16

Case 4, I. F. Six weeks after operation. Note the slightly changed attitude.

and the usual treatment of rest in bed in a plaster cast was given. She grew progressively worse; the kyphosis becoming so pronounced as to produce a typical deformity of the chest, arching forward until her sternum, on sitting, was almost in her lap. Her legs became involved in spastic paralysis and when first seen by the author she was unable to walk. Figure 15 shows the only method by which she was able to stand. Diagnosis: advanced Pott's disease of the eighth, ninth, and tenth dorsal vertebrae. Child was operated on August 1914.

In this operation a semilunar flap was turned back exposing the kyphos. The spinous processes were small and apparently inadequate for the splitting operation. They were chiseled off from four or five vertebrae. Then entering the chisel at the upper and lower extremities of the fascial incision, additional processes were sectioned subfascially. A tibial graft was secured long enough to reach and the ends tucked under the *unsplit* fascia at both ends of the wound. In order to make the bone fit comfortably around this curved line, it was carved, as a carpenter does a moulding, and bent into place; wound was closed by a running suture of catgut. In this case a plaster cast was applied and the patient put to bed. In the course of two or three weeks, the patient becoming uncomfortable, anxiety was felt about the wound and the cast was removed. The wound proved to be in good condition but the cast was not replaced; patient made an uneventful recovery, leaving the hospital in six weeks. She could walk before she left the hospital and has been running and playing ever since.

In the subsequent thirteen years she has been well and happy. For the last ten years she has attended public school without missing a day or being tardy. She has

FIG. 17

Case 4, I. F. Thirteen years after operation, thirteen years of happy student life without a pain.

proved to be precocious; has finished her second year of high school; and is preparing herself to be a teacher. The conclusion is forced upon us that in this case surgery has not been "disastrous".

For the purpose of making clear the security, comfort and absolute fixation of a graft placed subfascially by the tunneling method, *i.e.*, without splitting the fascia, the case of D. M. will be included in this report, although her age might exclude her from the children's class.

CASE 5. D. M., aged twenty, was seen on April 2, 1927. Inspection showed kyphosis in the lumbar region. She was run over by an automobile one year before and "jack-knifed" to such an extent that both hips were dislocated and her back broken at the third lumbar vertebra. She was carried home, the dislocated hips reduced, but the back overlooked. She was kept in bed for four weeks. Immediately upon assuming the upright posture, the kyphos became manifest. It has become more pronounced, giving her daily pain to such an extent as to incapacitate her. Skiagraphs showed erosion and absorption of the anterior margins, upper and lower, of the body of the second lumbar vertebra, diagonal fracture through the body of the third, with pronounced angulation due to the wedge-shaped vertebral body, with a possible superimposed tubercular process.

Fixation was advised and operation performed April 8, 1927. A straight tunnel was driven from the fifth to the first lumbar vertebra, sectioning the posterior processes subfascially at a safe level from the spinal cord. A one-inch incision was used for entering the osteotome. A five and one-half inch graft, three-eighths of an inch wide, full thickness of the cortex of the tibia, bare of periosteum, was secured and inserted into the tunnel. The tunneling osteotome was withdrawn; wounds were closed with 000 catgut, simple dressings were applied and patient was put to bed on a flat mattress, on her back. Operation required thirteen minutes.

The postoperative treatment of this case and the patient's rapid recovery read like a combination of Baron Munchausen and the Arabian Nights.

On the third day following the operation, feeling so inclined, the patient arose and used a vessel at the side of the bed, sitting in the upright posture. She has never used the bed-pan. At the end of a week she got up and walked, climbing into a wheel-chair unaided, to be transferred to another floor. On arrival at the ward where she was to be placed, she climbed out of the wheel-chair unaided, walked over to the bed and retired.

Two weeks following the operation she walked out of the hospital and rode to her home in a Ford. On the sixteenth postoperative day she took a joy-ride to a neighboring town in a Ford, *driving the car herself*.

On the seventeenth day she came to the writer's office, spent the afternoon pleasantly conversing and walking about the place; took supper with him and went with him to the meeting of the Jasper County Medical Society where her case was presented at a clinic. In order to get to the room in which the society met, she walked up the flights of steps at the approach of the building and up a long flight of stairs to the second floor, unaided. The only discomfort she felt was a slight stiffness of the scar on the shin from which the bone was removed. Her back was free from pain; she looked and acted as though she

had nothing the matter with her back; she stooped and picked up a knife from the floor as easily and comfortably as if she had never sustained an injury. In the fourth week following her operation, the patient attended a carnival being held in the town. Upon entering a dark room and sitting down on a bench, the bench was suddenly jerked from under her and she was precipitated unexpectedly down a long incline, arriving at the bottom with a bump. She rode the merry-go-round, indulged in all the trick performances and as a climax to her effort, apparently to break her back, rode what is called the "Whip" five times in succession. After these strenuous trials she is convinced that her back is strong.

Candor forces one to admit that the last word has not been spoken in the treatment of back injuries. The positive mechanical support secured by the subfascial implantation, *without splitting the fascia*, may prove of value in recent cases.

In order to demonstrate that positive bony contact of a graft is secured by this method, the case reported as Case 6 will be included.

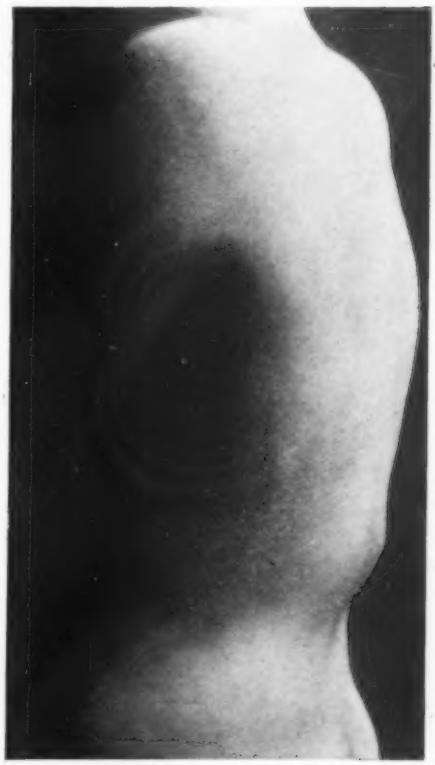

FIG. 18

Case 5, D. M. Before operation. Fracture of the second and third lumbar vertebrae.

CASE 6. M. Y., aged twenty-six, applied for treatment early in May 1920. Inspection disclosed kyphosis in the upper lumbar region. Her history showed that, when about twenty years of age, patient was playing ball and fell down; a heavy boy sat on her back, injuring it. Patient became progressively worse, and could not sit up all day. There was some embarrassment of left side; she was unable to move left leg well. For six years she ran the gamut of treatment and, when she first came under the observation of the writer, she was helpless. Diagnosis was made of tubercular spondylitis of the upper lumbar vertebrae. Fixation was advised.

Operation was performed, May 17, 1920. By the tunneling method a graft three-eighths of an inch wide, full thickness of the cortex of the tibia, six inches long, was implanted through a one-inch incision. Patient was permitted to walk in seven weeks; in eight weeks she rode home in the upright posture in a car; sat up and ate with the family at the table, retiring after a pleasant evening visit with the folks at home.

She grew decidedly stronger through the summer months. The following fall she took up her occupation of teaching and has taught every year since without a back symptom. Today, seven years following her operation, she is as strong, agile and healthy as any other normal person. The skiagraph taken seven years after her operation shows the graft still present, which conclusively proves that in its implantation *good bony contact was secured.*

FIG. 19
Case 5, D. M. Lateral view of spine before operation, April 2, 1927.

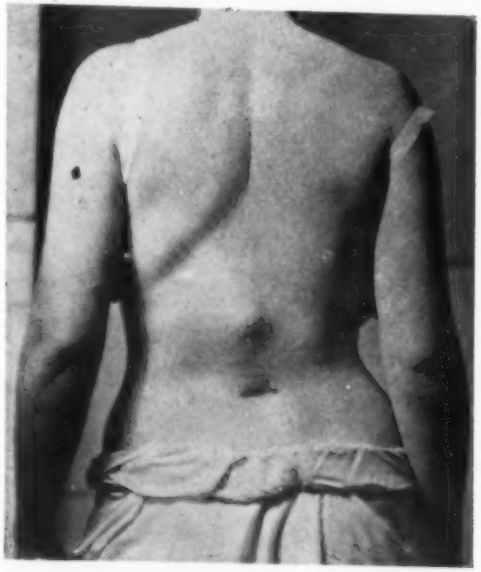

FIG. 20

FIG. 21

FIG. 22

Case 5, D. M. Two weeks after operation. A five and one-half inch tibial graft was placed subfascially bridging the lumbar vertebrae. Note the early compensatory mobility of the spine.

FIG. 23

Case 5, D. M. Anteroposterior view after operation, April 29, 1927.

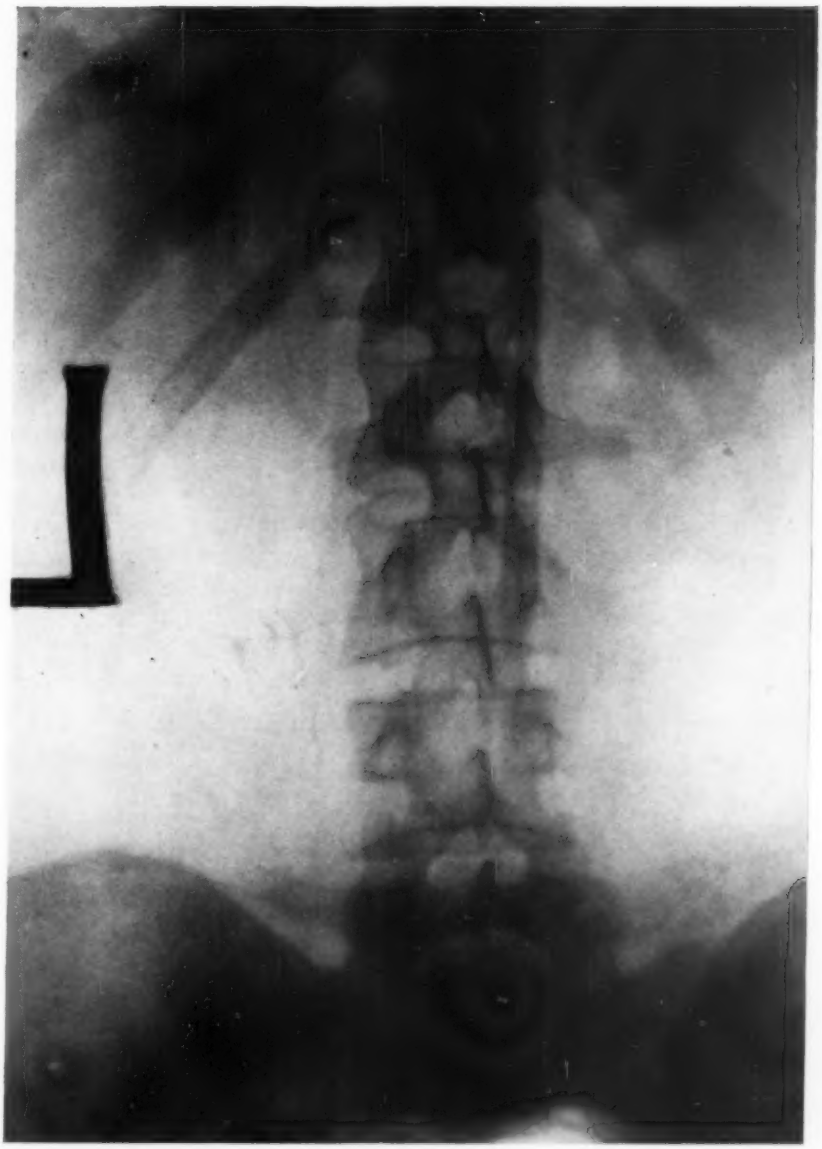

FIG. 24

Case 6, M. Y. Anteroposterior view June 18, 1927, seven years after operation.

SUMMARY

An immediate immobilization of the tubercular spine is necessary. This accomplished, the normal use of the remainder of the body not only does not interfere with, but favors, the healing process, by raising the resistance of the organism to infection. The implantation of a long autog-

enous bone splint under the unsplit lumbodorsal fascia, gives immediate support to the weakened spine; obviates the necessity for external splints, braces or casts; and renders immediate movement safe. The tunneling method permits of its emplacement quickly, with least trauma, without the introduction of any foreign material (catgut, kangeroo tendon, etc.). The maximum of correction possible with safety, can be secured at operation, and the spring effect of the graft continues the correction until union of the graft to the amputated posterior processes occurs. Here correction ceases. The tips of the severed processes drop snugly to the dorsal surface of the graft and furnish excellent centers of osteogenesis immediately opposite the stumps, thus surrounding the bone splint with a complete ring of new bone at the point of contact. The persistence of the graft after seven years proves that bony contact continues, and that fusion of the splint with the posterior processes occurs. The retention of the splint *in situ* is absolute, being held in place by the taut lumbodorsal fascia and the laterally placed lumbodorsal muscles.

The short time required for the implantation; the ease with which it is secured, using the tunneling tool; the small incision; the freedom from postoperative pain, and the freedom from casts or other restraining apparatus should recommend this method.

# FRACTURE OF BOTH THE CORONOID AND THE OLECRANON PROCESSES OF THE ULNA. INDICATIONS FOR OPERATION AND TREATMENT

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The occurrence of a fracture of both the coronoid and the olecranon processes is unusual and presents difficulties in treatment. The case reported herewith has led to a study of these fractures which have resulted frequently in partial or complete loss of function.

Because of the very limited number of reported cases, it has been necessary to review all fractures of the coronoid process.

## CLASSIFICATION OF FRACTURES OF THE CORONOID AND THE OLECRANON PROCESSES OF THE ULNA

I. Types of associated fracture of both coronoid and olecranon processes of the ulna.
   1. Uncomplicated fracture of both processes.
   2. Fractures complicated by:
      a. Posterior dislocation of elbow.
      b. Upward dislocation of head of radius.
      c. Multiple comminuted fractures about the elbow.
      d. Associated injuries to soft parts.

II. Types of fracture of the coronoid process.
   1. Fracture uncomplicated by associated injuries.
   2. Fractures complicated by:
      a. Posterior dislocation of elbow.
      b. Lateral dislocation of elbow.
      c. Fracture of the head of the radius.
      d. Posterior dislocation of elbow with a fracture of the head of the radius.
      e. Fracture of the condyles or shaft of the humerus.
      f. Multiple fractures with or without dislocation of the head of the radius.
      g. Fracture of the olecranon process.

III. Types of fracture of olecranon process.
   1. Uncomplicated fracture.
   2. Fractures complicated by other fractures or dislocations of the radius or ulna.

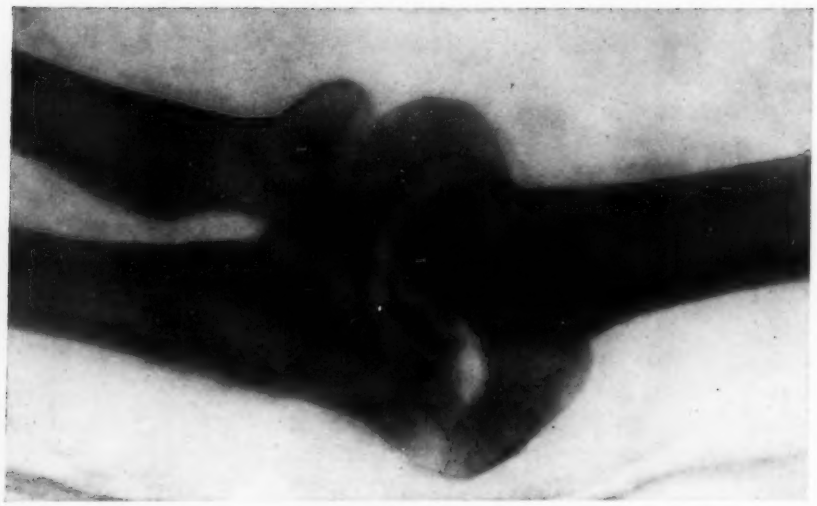

FIG. 1

There was downward displacement of the coronoid process due to extension of the arm in an effort to reduce the olecranon displacement.

## REPORT OF CASE OF FRACTURE OF BOTH CORONOID AND OLECRANON PROCESSES

F. R., male, aged twenty-eight, a milk driver. While hurrying on an icy sidewalk, the patient slipped and fell, striking upon the point of the flexed elbow. He had immediate pain with loss of function. The history otherwise was negative. The patient had always been well.

On examination the right forearm was semiflexed and moderately pronated. Any attempt to move the arm was painful in the elbow. There was some swelling and a large fragment of the olecranon could be felt displaced about two centimeters posteriorly. A roentgenogram was taken which showed a fracture with separation of the olecranon process. However, due to the overlapping of the head of the radius a fracture of the coronoid was not noticed at the time.

FIG. 2

By moderate flexion of the forearm the downward displacement of the coronoid had been reduced, but there was a wide separation again of the olecranon process.

It was possible by extending the forearm completely to approximate the olecranon fragment to the shaft, although it caused some pain. This reduction was fairly well maintained by adhesive straps and by placing a moulded splint upon the arm in extension.

A second roentgenogram (Fig. 1) was taken and the olecranon was found in fair approximation, but there was now seen to be a complete

fracture at the base of the coronoid process with a downward displacement of the fragment.

The extension splint was removed. There was marked swelling of the forearm and also of the area in front of the elbow, over which there was considerable pain and localized tenderness.

In order to see if the coronoid fragment could be reduced by flexion of the elbow, a roentgenogram (Fig. 2) was taken with the arm flexed. This showed a good reduction of the fragment.

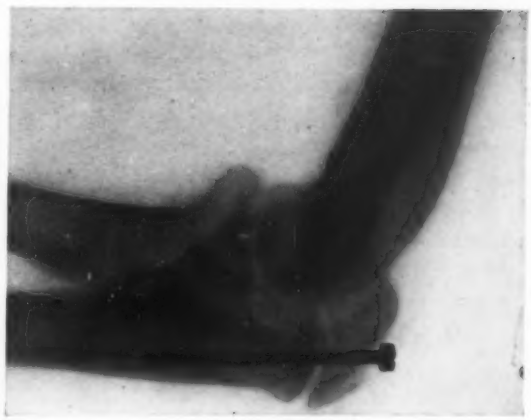

FIG. 3

Six weeks after operative fixation of the olecranon process and correction of the coronoid displacement by flexion. There was no evidence of an exuberant callus. There was no limitation of flexion and only ten degrees limitation of extension.

Since it was impossible to reduce both fractures by either flexion or extension an open operation was advised, with fixation of the olecranon fragment followed by immobilization in flexion which the roentgenograms showed would satisfactorily correct the coronoid displacement.

*Operation*, Presbyterian Hospital, November 22, 1926.—A longitudinal incision was made over the back of the elbow with dissection of the skin on both sides. A transverse fracture of the olecranon with a tear of the capsular ligament was exposed. The joint was cleared of blood and the fractured surfaces of the olecranon fragments were approximated. A hole was drilled through the fragment from the tip and continued longitudinally into the shaft of the ulna to fit a Lambotte gold-plated screw six centimeters long and three millimeters in diameter. This was screwed into position, holding the olecranon fragment solidly in place. The head of the screw was buried deeply under the tendon of the triceps muscle. The capsule and skin were closed. The arm was put up in a sling in moderate flexion. Roentgenograms showed good anatomical alignment. At the end of one week the sling was removed and the patient was permitted to use the arm slightly as he wished. At the end of two weeks he could extend and flex the arm about ninety degrees. After six weeks there was no evidence of excessive callous formation (Fig. 3). Flexion was completely normal and extension was limited about ten degrees. A good fibrous callus could be palpated over the olecranon.

At the end of two months strength and function were so good that the patient was permitted to go to work. The screw had given him no symptoms. After seven months of carrying and delivering milk, he had no complaints or interference with function.

The first report of the occurrence of a fracture of both the coronoid and olecranon processes of the ulna was made in 1861 by Moutet. I have been able to find only six case reports[1] of fracture of both the coronoid and olecranon process in the literature (Table I). A fracture of the coronoid process alone was first diagnosed clinically by Combes-Brassard[2] in 1811, by palpating a movable mass in front of the elbow which interfered with flexion, in a patient who had fallen upon his hand with forearm in extension three months before.

Kühnholtz[3] in 1826 and again in 1845 wrote, emphasizing the impor-

tance of this fracture. There was a limited number of cases reported with the clinical diagnosis until 1844, when Astley Cooper[4] probably reported the first proved fracture of the coronoid, which was observed upon a cadaver. Urlichs[5] in 1878 recognized the various types of injury producing a fracture of the coronoid process and Hamilton[6] in 1884 reported two cases diagnosed clinically.

Seiffert[7] in 1911 collected twenty-seven cases of fracture of the coronoid process, one of which (Hodges[8]) was incorrectly included. This fracture is rarely recognized (Cotton[9]) even today with the constant use of the

TABLE I

CASES OF FRACTURE OF BOTH CORONOID AND OLECRANON PROCESSES

| *Author* | *Sex* | *Age* | *Mechanism* | *Extent of Fracture* | *Treatment* | *Result* |
|---|---|---|---|---|---|---|
| Moutet 1861 | Female | 70 | Fall on semi-flexed arm. | Coronoid process separated .5 cm. Olecranon process separated 2 cm. Also associated fracture of mid-humerus. | Forearm bandaged at right angles. | Non-union of all fractures at death 43 days later from cerebral apoplexy. |
| Samuel Cooper 1884 | .... | .. | .... | Coronoid process slight separation. Olecranon process moderate separation. Upward dislocation of head of radius. | None. | Great deformity. Cadaver. |
| Beck 1901 | Male | 46 | Fall on hypothenar eminence with elbow in extension. | Coronoid process slight separation. Olecranon process posterior angulation. | Reduction of angulation by manipulation. Bandage in extension. | Good function. |
| Basset 1922 | .... | .. | Severe injury. | Coronoid process marked separation. Olecranon process separation of 2 cm. | Open operation. Screw through coronoid process. Olecranon fragment wired to shaft. | Good function. Slight limitation flexion and extension at 2½ months. |
| . Jean 1923 | Male | 22 | A fall on the point of the acutely flexed elbow. | Coronoid process separated 1 cm. Olecranon process separated 2 cm. | Open operation. Coronoid wired to shaft. Olecranon fixed by 2 wires. Elbow at right angles 3 weeks. | Good function, 10–15 degrees limitation of flexion and extension after 3 months convalescence. |
| A. Mouchet 1923 also by Fournier and Le Gac | .... | 12 | Violent fall. Mechanism doubtful. | Marked separation of coronoid and olecranon. Posterior dislocation of elbow. | Reduction of coronoid by elbow flexion 3 weeks. Olecranon fragment blocked extension to 110 degrees. Operative removal 6 weeks later. | Fair result. Extension limited to 150 degrees following removal of olecranon fragment. |
| G. L. McWhorter | Male | 28 | A fall on the point of acutely flexed elbow. | Coronoid process slightly separated by extension. Olecranon process separated 2 cm. | Open operation. Olecranon fixed by screw. Coronoid reduced by flexion elbow 1 week. | Good function, 10 degrees limitation of extension. Two months' convalescence. Working until accidental death nine months later. |

x-ray. It is possible that some are overlooked, due to their more frequent occurrence with a posterior dislocation of the elbow which may escape routine examination. Ferguson[10], before the use of the x-ray, thought that the tip of the coronoid was usually broken off in a posterior dislocation of the elbow.

R. Jones[11], while recording only a few instances of fracture of the coronoid alone, thinks that the proper treatment is important, due to the danger of interference with flexion by the fragment, or the development of a traumatic myositis ossificans. Ochsner[12] has recognized that a fracture of the coronoid may be the cause of a recurrent dislocation of the elbow, later requiring resection.

*Etiology.*—The cause of a fracture of the coronoid alone may be due to a direct or an indirect force. The indirect force is the more common, and may be due to a number of causes:

1. A fall upon the hypothenar eminence of the hand with the forearm either in extension, which is the most frequent cause of all, or in semiflexion. Lotzbeck[13] demonstrated that the force was carried through and the coronoid was torn off by striking against the trochlea. A posterior dislocation of the elbow may also result.

2. A force applied on the posterior side of the humerus with semiflexion of the forearm (Moutet).

3. A hyperacute external flexion of the elbow. Here a tip of the coronoid process presses violently against the fossa of the humerus. However, the humerus is checked anteriorly by the radius; consequently, a fracture of the head of the radius is the more common.

4. A muscular contraction of the brachialis anticus muscle. The case of Liston[14] is thought to have been due to this type of injury, in which a child hung suspended by one hand for some time. However, Urlichs states that it is impossible to fracture the coronoid by a muscle pull, due to the location of its insertion.

5. According to Abrahamsen[15], a lateral motion of the elbow with abduction or adduction might cause fracture of the coronoid.

6. A blow or fall on the point of the elbow.

A direct force causing a coronoid fracture is rare. In Cooper's case (Seiffert) a horse kicked directly against the front of the elbow. In Wendt's[16] case, there was an extensive direct force with an open wound and multiple injuries.

*The etiology of simultaneous fracture of both the coronoid and the olecranon processes.*—In the seven cases reported (Table I) the fracture of both processes was the result of:

1. A fall upon the point of the elbow in two cases.

2. A fall upon the hypothenar eminence with the elbow in extension in one case.

3. A fall upon the arm with the forearm flexed in one case.

4. A severe injury in one case.

5. In the remaining two cases of the seven, the cause was not determined.

In the fractures of both the coronoid and the olecranon, the ages varied from twenty-two to seventy years and of the cases where the sex was stated, there were three males and one female.

*Pathological Anatomy.*—There may be a fracture of the tip or of the base of the coronoid process. In all fractures of the coronoid collected by Seiffert there were noted only two of the tip and eleven of the base. In a fracture of the base of the coronoid the fragment may be completely detached, attached at one point, or separated from the bone completely either remaining attached to the brachialis muscle or without remaining so attached. In associated fractures of both the coronoid and the olecranon, the coronoid was fractured at the base in six cases and not noted in S. Cooper's case.

*Position of the coronoid and olecranon fragments in the seven cases reported.—*

1. There was marked separation of both the olecranon and coronoid processes in three cases.

2. There was marked displacement of the olecranon and little separation of coronoid fragment in three cases (1, 2, 7). There was also an upward dislocation of the head of the radius in Case 2.

3. There was a posterior angulation of the fracture of the olecranon in Case 3, with only slight displacement.

Seiffert collected in all only twenty-six cases of true fracture of the coronoid. There were six uncomplicated fractures, involving only the coronoid, while the other twenty were complicated. There were five with a posterior dislocation and two with a lateral dislocation of the elbow. Two were associated with a fracture of the head of the radius. In one there was a posterior dislocation and a fracture of the head of the radius. In two cases there was a fracture of the condyles of the humerus and in one a fracture of the shaft. In four cases there was an extensive crushing of all of the bones and extensive injuries to the soft parts. Two of these patients died, in one the arm was amputated, and in one there was complete paralysis. In three cases there was a fracture of the olecranon process. In one of these there was also a dislocation of the head of the radius and in one other, a fracture of the middle of the humerus. In only one case was the injury limited to fractures of the olecranon and coronoid processes.

*Symptoms of fracture of the coronoid and the olecranon processes.*—Where only a crack or fissure is present an x-ray is necessary for a diagnosis.

There may be no symptoms with a fissured fracture of the tip of the coronoid process alone (Cotton). However, the symptoms depend largely on the amount of trauma, the displacement, and on whether the tip or the base is broken. The anterior portion of the elbow is often greatly swollen by a hematoma and flexion is limited. Crepitation of the fragment may be elicited. There is frequently a localized tenderness in front of the elbow.

When a fracture of the olecranon with displacement is present, the fragment may usually be palpated and crepitation may be obtained. There

is a loss of the function of extension of the forearm and usually moderate swelling.

With a fracture of both the olecranon and the coronoid there is usually a semiflexion of the elbow. The anterior-posterior diameter is greatly increased. Usually the forearm is pronated strongly, but supination may be complete. Both flexion and extension are usually limited.

One of the most characteristic symptoms in the author's case was the pain in front of the elbow on extension and the development later of marked swelling in front of the elbow. In Mouchet's case, the deformity due to the posterior dislocation was the presenting symptom. A fracture of the coronoid may easily be overlooked in the x-ray because the shadow of the head of the radius may overlap and obscure it. Later roentgenograms may show displacement of the fragment in an attempt to set the olecranon by extreme extension, as in the writer's case.

It is of great importance to diagnose even a fissure fracture of the coronoid because early use of the elbow by heavy work may produce an exuberant callus or traumatic myositis ossificans with limitation of elbow function.

*Prognosis.*—The prognosis of fracture of the coronoid depends upon the extent of separation, early recognition, the presence of associated injuries, and proper treatment.

In fracture of the tip of the coronoid a fibrous union will probably result, due to the poor blood supply from the capsular ligament. However, Astley Cooper (1844) stated that one should attempt to make this ligamentous union as short as possible. Hamilton (1884) believed a fibrous union of the olecranon or the coronoid would produce good function, providing it was not too long. He advocated early motion in fracture of the coronoid as being more important than a possible fibrous union.

In fracture of the base of the coronoid the prognosis is good if there is no separation, but mobilization should be early. However, there may be overabundant callus or osteophyte formation interfering with motion. Robert Jones has emphasized avoiding massage, excessive passive motion, and heavy work until bone repair is complete to prevent excess callus or traumatic myositis ossificans. Where there is a marked separation of the coronoid fragment, it must be corrected to prevent interference with flexion. In the absence of other injuries it may be corrected usually by flexion of the elbow with a good result. However, as Bradford[17] showed in 1883, flexion does not always prevent a prompt recurrence of a posterior dislocation of the elbow. A good functional result may be obtained with moderate separation of the olecranon process even with fibrous union, although there may be interference with extension, as in Mouchet's case.

The prognosis is not so good where there are associated injuries, such as injury to the head of the radius, posterior dislocation of the elbow, or a tendency to exuberant callus, and osteophyte formation around the joint. In several cases of complicated fracture of the coronoid alone, which were undiagnosed or improperly treated, resection of the elbow and even amputation had to be done (Seiffert). Robert Jones states that a traumatic myositis

ossificans is more common after a posterior dislocation than after merely a fracture of the coronoid. He has obtained numerous recurrences following operative removal of the new bone, which should never be done until all osteogenetic activity has ceased.

In the three cases of fracture of both the coronoid and the olecranon (Table 1) where the open operation was performed immediately, due to inability to approximate both fragments by manipulation, the functional results were good. By non-operative methods of treatment there was one non-union at forty-three days, one case with a poor result due to blocking of extension, operated on later, and only one case with a good result, treated by Beck, with the arm in extension. In this latter case, however, there had been only a slight displacement of the coronoid with angulation of the olecranon fragment.

*Surgical Anatomy.*—The author has attempted to clear up several points of interest by dissections upon the cadaver and the experimental production of fractures of the coronoid and olecranon.

Usually about one-half of the brachialis anticus muscle insertion is along the lower two-thirds of the coronoid process, the remainder is spread along the shaft of the ulna. The tip of the coronoid is above the insertion of the muscle, but the capsular ligament is attached along its anterior border.

It is possible, in a fracture of the base of the coronoid, for the fragment to be held in position by the remaining fibres of the brachialis anticus attached to the shaft, to be freed entirely from the shaft by a tearing through of these muscle fibres and then drawn upwards by the contraction of the attached brachialis fibres, or to be detached entirely from the muscle and displaced in any position.

If the coronoid fragment cannot be replaced by complete flexion of the forearm, it is usually possible to replace it by manipulation: First, by extending the forearm with pressure on the soft parts directly over the fragment, which will tend to correct any rotation; then, by flexing the forearm while maintaining pressure down and backward, the fragment may be pressed into its normal position. The forearm should be immobilized in a flexed position. If the olecranon is also displaced, it must be fixed by an open operation.

Where there is at first no displacement of the coronoid process extreme extension of the elbow may push the fragment forward and downward along the shaft of the ulna, as in the writer's case. Upon flexion the soft parts hold the fragment until a right angle is reached, beyond this pressure of the forearm forces it almost directly into its normal position. If the fracture of the coronoid extends below its base so that the joint surface of the fragment is U-shaped, it may be impossible to replace it by manipulation, and open operation is necessary.

Anatomical exposure of the coronoid fragment is not easy, because of the danger of injury to the ulnar nerve. The best approach is by an incision posteriorly to the elbow with a slight medial hook at the lower end. With the skin flap dissected up the ulnar nerve may be avoided by hugging

the bone or preferably the nerve may be dissected out and retracted upward. The flexor muscles along the medial surface of the ulna may be cut at their origin leaving enough fascia to suture to later. The soft parts are pushed upward and the joint capsule and coronoid process are exposed. The coronoid fragment may be fixed, if necessary, by a screw directly through the shaft into it, or by a suture. If greater exposure of the joint is needed, the muscles arising from the medial epicondyle of the humerus may also be cut near their origin.

With fracture of both the olecranon and coronoid together with an extensive tearing of the capsular ligament, it may be possible to better expose the coronoid by dislocating the radius and ulna laterally.

*Treatment.*—Treatment depends on the degree of separation of the coronoid and olecranon processes and on the presence of associated injuries. Where there is no separation of either the coronoid or olecranon fragments, the arm may be kept in a sling for ten days. Where there is a fracture of both processes with a separation of only one fragment, an attempt to approximate the coronoid by acute flexion or the olecranon fragment by extension of the elbow may be successful. However, where both fragments are completely fractured and detached from the supporting ligaments, flexion will result in a wider separation of the olecranon although reducing the coronoid displacement, while extension of the forearm to approximate the olecranon fragment will separate the coronoid fragment. Under these conditions, an open operation is necessary. Also, where either the coronoid or the olecranon fragment is displaced and cannot be reduced by manipulation and fixation of the elbow, or where both the olecranon and coronoid fragments are displaced, operation is indicated. Operative treatment, where the coronoid fragment may be approximated by flexion and manipulation, should be limited to fixation by suture or screw of the displaced olecranon fragment only. The forearm may be kept in flexion for a week or ten days followed by early mobilization.

Where reduction of the coronoid fragment may be obtained by flexion of the elbow, the operative fixation by screws or suture, as in Jean's case, is undesirable because of the increased trauma, possible injury to the ulnar nerve, and introduction of foreign materials. Under conditions where the coronoid fragment cannot be reduced by flexion or manipulation, as in Basset's case, it must be exposed and fixed in normal position, if necessary by a foreign body or suture.

Rest is indicated in the first week or two. Early mobilization is indicated but motion should be left entirely to the patient. Forced motion should not be used. Active work should not be permitted for two or three months and if there is an exuberant callus not until bone regeneration is entirely completed.

## POSTSCRIPT

The writer's patient was accidentally killed August 22, 1927, nine months after the operation upon the elbow. Postmortem examination (Fig. 4) showed that the position of the fragments of the coronoid and olecranon processes was excellent. The

FIG. 4

Specimen of healed fracture of coronoid and olecranon processes in writer's case, removed after accidental death nine months later. There was a narrow, thin cartilage-like line at the site of fracture of the olecranon with a wearing away of the joint cartilage, anteriorly to it (*a*).

There was solid bony union of the coronoid fracture with a cartilage-like bridge (*c*) over the center. On both sides (*b* and *d*) were superficial defects in the bone covered by processes of fat.

line of union of the olecranon fracture was marked by a thin, white line extending completely around the bone and fusing in front with the joint cartilage, which it resembled. Anterior to this line (*a* in Fig. 4) the joint cartilage was worn away for a distance of from two to five millimeters. This was evidently due to a slight lowering of the olecranon fragment at the operation.

The line of union of the coronoid fracture was one centimeter anterior to the olecranon fracture line. There was solid fusion of the coronoid fragment to the shaft. The union was covered apparently with a three-millimeter bridge of thin cartilage, which fused smoothly with the joint cartilage (*c* in Fig. 4). On both sides of this were shallow pockets (*b* and *d* in Fig. 4), evidently the result of some bone absorption. These contained flat tongue-like processes of fat, one of which (*b* in Fig. 4) was fused at its tip to the cartilage.

The brachialis anticus muscle was very thick and its insertion extended for three centimeters along the shaft of the ulna and the lower two-thirds of the coronoid process. The tip of the coronoid process was free for a distance of five-tenths of a centimeter.

The screw, which was still firm, was removed from the olecranon and the specimen was sawed through longitudinally. A thin, one-millimeter layer, apparently of cartilage, extended throughout the entire union of the olecranon fragment.

There was such a complete bony fusion of the base of the coronoid that, grossly, the old fracture line could not be seen, except at the joint surface. In the middle, this was bridged over by a paper-thin, cartilage-like layer, which was much thinner than the normal joint cartilage.

There was a small area of bone absorption around the tip of the screw and a second larger area posterior to the screw at its middle. This latter area was about five-tenths of a centimeter in diameter and was distal to the line of olecranon union. It extended through the dense cortical bone from the screw to the periosteum, but did not involve the latter. It contained granulation-like material which contained numerous cells resembling small lymphocytes. Further microscopic studies will be made.

There was nowhere any evidence of bony exostosis or traumatic myositis ossificans.

## BIBLIOGRAPHY

1. MOUTET: Montpellier Médical, VII, 425, 1861. Quoted by Seiffert.
COOPER, SAMUEL: Quoted by Seiffert from Traité des Fractures et Luxations by Hamilton et Poinsot, 383, 1884.
BECK, CARL: Ueber die Fractur des Processus coronoideus ulnae. Deutsche Ztsch. f. Chir., LX, 193, 1901.
BASSET, A.: Fracture double de l'extrémité supérieure du cubitus (fracture de

l'olécrône à grand écartement, fracture de l'apophyse coronoide). Bull. et mém., Soc. de Chir. de Paris, XLVIII, 1417, 1922.

JEAN, G.: Fracture du coroné et de l'olécrône traiteé par l'osteosynthèse. Bull. et mém. Soc. de Chir. de Paris, XLIX, 1262, 1923.

MOUCHET, A.: Bull. et mem. Soc. de Chir. de Paris, XLIX, 1264, 1923.

FOURNIER ET LE GAC: Luxation du coude chez l'enfant avec fracture du coroné et fracture de l'olécrane. Bull. et mem. Soc. anat. de Paris, LXXXXI, 304, 1921.

2. COMBES-BRASSARD: Mémoire sur la fracture de l'apophyse coronoide, italien et francais, 1811. Quoted by Seiffert.
3. KÜHNHOLTZ, M. H.: Ephemerides médicales de Montpellier, 1826. Mémoire sur la fracture de l'apophyse coronoide du cubitus. Montpellier, L. Castel, 1845.
4. COOPER, ASTLEY: Dislocations and Fractures of the Joints. Philadelphia, Lea and Blanchard, 1844.
5. URLICHS, K.: Ueber die Fractur des Processus coronoides Ulnae. Deutsche Ztsch. f. Chir., X, 399, 1878.
6. HAMILTON, F. H.: A Practical Treatise on Fractures and Dislocations. Philadelphia, Lea and Blanchard, 1860.
7. SEIFFERT, A.: De la Fracture de l'Apophyse coronoide du Cubitus. Thèse, Paris, June, 1911.
8. HODGES: Boston Med. and Surg. J., LXXV, 383, 1866.
9. COTTON, F. J.: Dislocations and Joint-Fractures. Ed. 2. W. B. Saunders and Co., Philadelphia, 340, 1924.
10. FERGUSSON: Quoted by Hamilton (6). 1860 and 1884.
11. JONES, ROBERT: Injuries of Joints. London, Oxford Univ. Press, 92, 1915; Orthopedic Surgery of Injuries. London, Oxford Univ. Press, I, 1921.
12. OCHSNER, A. J.: Surgical Diagnosis and Treatment, Philadelphia, Lea and Febiger, IV, 86, 1922.
13. LOTZBECK: Quoted by Abrahamsen (15).
14. LISTON: Quoted by Hamilton (6).
15. ABRAHAMSEN: Ugesk. f. Laeger, 85: 89, Feb. 8, 1923.
16. WENDT: Archiv und Atlas der normalen und pathologischen anatomie in typischen Röntgenbildern. Hamburg, L. Gräfe et Sillem, 360, 1910. Quoted by Seiffert.
17. BRADFORD, E. H.: Boston Med. and Surg. J., CIX, 59, July 19, 1883.

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## DISCUSSION

NOTE: In the July issue of the *Journal* were published two papers presented at the Annual Meeting of the American Orthopaedic Association: "Operations on the Upper Extremity; Problems in Kinetics; End Results" by Dr. Arthur Steindler (IX, 404, 1927), and "Transplantation of the Trapezius for Paralysis of the Abductors of the Arm" by Dr. Leo Mayer (IX, 412, 1927). At the meeting these two papers were discussed together. The discussion is presented below.—*Editor.*

DR. JOHN WILSON, Los Angeles, Calif.: I simply wish to express my appreciation to Dr. Steindler for his very interesting presentation. He shows what may be done in the reconstruction of the upper extremity if one has a thorough knowledge of the action of the muscles which control the shoulder, elbow and wrist.

DR. STERLING BUNNELL, San Francisco, Calif.: Dr. Mayer is to be congratulated on his result. As far as I have been able to find in the literature there is no such result reported. Some have reported getting the arm to the horizontal when the elbow is flexed but no one has reported getting it straight out. Evidently there is a mechanism about the shoulder which makes it difficult to get the arm up. I suppose it is because we are bipeds built on quadruped architecture; in other words, quadrupeds move their front limbs forwards and backwards and seldom if ever abduct them to above the head, and so we have not proper muscular provision for this motion. I believe that in the higher apes and in the human, the clavicular origin of the pectoral muscle is a distinctive development and is not present in other quadrupeds. In rare cases, even a separate nerve supply to the clavicular portion of the pectoral muscle has been found coming from the suprascapular nerve.

There is another factor which makes it difficult for this operation to be successful, so that arthrodesis has been up to this time the preferable procedure, and that is the contracture of the great strong muscle, the latissimus dorsi which holds the arm down. It has often been noticed that after a patient has held his arm down at his side for a month or two, because of pain in the shoulder or other cause, he then is unable to abduct his arm to above his head. That is what the deltoid has to compete against. The latissimus dorsi has a nine-inch stretch, which is the longest of any muscle in the body. If that muscle is kept in relaxation, it will undergo contracture, and it will be very difficult for the elevators of the arm, which are weaker and work under great mechanical disadvantage, to then raise the arm.

DR. ARTHUR STEINDLER, Iowa City, Ia. (Closing his part of the discussion): In regard to Dr. Mayer's presentation, I said that arthrodesis of the shoulder was the only operation heretofore recommended and acceptable. I think I was right. Unfortunately, only for a few minutes, because I must say that this technique that Dr. Mayer has presented is excellent. I have an idea why the former attempts, such as those of Hillebrand, Gersuny, and others, have failed. I have an idea why his succeeded. I believe it is not only because of the fascial flap but because he anchors it underneath the acromion and thereby produces an entirely different proposition from that pertaining to the deltoid muscle. That is the key to the operation. The deltoid muscle is a very difficult pieee of architecture. It has its belly above and below the axis of the joint which it moves. The pressure on the joint is enormous. Dr. Mayer has solved it at least mechanically. It is interesting from the view-point of anatomy. The trapezius is a very important muscle. This muscle consists of five different portions and is innervated by five different branches. It has five different functions and this is one more added to it. I hope it will stand up under it.

As far as my own paper is concerned, I have nothing more to add.

DR. LEO MAYER, New York, N. Y. (Closing his part of discussion): I did not have a chance to discuss Dr. Steindler's paper but I am sure I am voicing the sentiments of all those gathered here when I congratulate him most warmly. Just exactly as we associate certain names with operations on the foot, such as those of Whitman, Davis, and Michael Hoke, so all of us in thinking of operations on the paralytic arm think of Steindler. He has done more for the paralyzed upper extremity than any one in this country and perhaps more than any one else in the world.

I am not going into a discussion of the details of his paper. That would take several hours. I can touch only on a few points. In spastic paralysis of the fingers there is very little to accomplish. I, myself, am always fearful of the results.

In cases of pronation spasm of the forearm instead of transplanting the flexor carpi ulnaris, I have been using the flexor carpi radialis. It is very easy to free its tendon for six or eight inches, to free also the pronator radii teres, suture the two together, and then bring them around the arm in a spiral direction, and attach them to the radius, through a drill opening running from behind, downward and forward. The results are good. We are not only subtracting from the pronator effect but adding to the power of supination. At the shoulder I have advocated in suitable cases the transplantation of the trapezius, but I do not want for one instant to detract from the value of arthrodesis. Arthrodesis is an unusually important operation in those cases where only the trapezius serratus and the rhomboids have escaped paralysis. In such cases there is no other operation that will do what an arthrodesis will do. I hope, however, that in those cases where supplementary muscles are present some of us will try out the operation I have suggested.

I want also to commend the efforts of Dr. Steindler in working out the exact mechanism of the arthrodesis. Dr. Steindler stated, as I understood him, that when the serratus is present, it is better to arthrodese the arm in a forward position, because you then get a much greater range of motion and the serratus anticus has a chance to use its contractile power, whereas if the serratus anticus is paralyzed, it will be much better if the arm is arthrodesed in the lateral position. It is by a careful analysis of the muscles, such as Dr. Steindler has made, that we are going to improve the end results of arthrodesis of the shoulder. I do not think we ought to adopt the dictum that the lateral position is always correct. My chief, Dr. Albee, has for many years used the forward position of the arm. Unquestionably the best results will be secured by determining the position according to the particular muscles which are active in the given case.

## DISCUSSION

NOTE: Below is presented the discussion which followed the paper entitled, "A Second Report on a Hitherto Undescribed Dystrophy, Probably of Luetic Origin, Affecting, Particularly, the Joints of the Lower Extremity," read by Dr. C. F. Eikenbary at the meeting of the American Orthopaedic Association, June 1927. The paper was published in the July issue of the *Journal* (IX, 387, 1927).—*Editor.*

DR. J. E. STEWART, St. Louis, Mo.: I think we are all interested in seeing a rare bone condition. We do not see many that are rare and this is certainly a unique one. Dr. Eikenbary sent his previous report to me and I showed the pictures to Dr. Sherwood Moore, our roentgenologist at Washington University, St. Louis. From the x-ray alone he said he would be inclined to call it a parasyphilitic lesion and I think most of us would, from the x-ray picture, say that there were a great many things about the whole story that were not the picture of syphilis or of a syphilitic arthrodesis. The fact that the patient had a joint that resembled a Charcot joint in the x-ray, resembled it on clinical examination in most ways in that there was no pain, and with as much destruction of the joint as was present in this patient, would make one think of this condition. However, since the condition has been present for so long a time, there would certainly be other signs of nerve involvement if it were a Charcot joint. I cannot offer the explanation that Dr. Eikenbary has been looking for for fourteen years.

DR. ARTHUR STEINDLER, St. Louis, Mo.: Dr. Eikenbary's paper has been a most excellent presentation of a most unusual condition, in fact so unusual that it is very hard for me to make any remarks regarding it, since my experience furnishes me next to nothing about the condition. We have had only one case that resembles it in which the diagnosis of syphilis was without doubt, and in which the destruction of the bone had gone on to a very great degree. It brings up the question of what shall be our attitude toward the Charcot joints as we see them. The definition of Charcot joints is a reaction of an insensitive joint to traumatism and it may not necessarily be due to syphilis. Assuming this definition still holds good, it raises a great deal of embarrassment. Charcot joint is found not only in syphilis but also in myelitis and in syringomyelia. From our files we found forty patients with fifty-five joints in a recent review of Charcot joints. All of them were adults. None of them had congenital or hereditary lues. In two of them the joints involved were in the upper extremities. Seven of the forty joints were in tabetics in which the joint symptoms were the primary and early symptoms according to the history. It has been reported that as many as eight years may elapse between the first tabetic sign and the appearance of the tabetic joint symptoms. So we must be very careful in the diagnosis of tabetic joints and also in the exclusion of such a condition. Of course the Argyll Robertson pupil and the absence of knee jerks are the most prevailing tabetic symptoms. I would also point out that while we are holding on to the insensitiveness as the characteristic symptom, we must not forget that this symptom is often clouded by complications. In two of our cases we had a complicating osteomyelitis which obscured the diagnosis of Charcot joint very materially. I must conclude from this paper, which I enjoyed very much, that the condition presented is one of syphilis in which the true nature became revealed only later in life. So far I cannot see that we are dealing with a true tabetic condition, because true tabetic symptoms failed to appear. On the other hand, the broader definition of Charcot joint, as the reaction of an insensitive joint to traumatism, not necessarily of tabetic basis, may permit classification of this case under this group.

# News Notes

## VIRGIL PENDLETON GIBNEY

The death of Dr. Virgil P. Gibney was announced on June 16, 1927, at Bridgeport, Conn.

Gibney is dead. One of the fathers of Orthopaedic Surgery has been called away. The world is poorer by his loss!

Dr. Gibney was born in Jessamine County, Kentucky, on September 29, 1847. Had he lived three months longer he would have completed his eightieth year. He received his early education in the South. He was graduated as a Bachelor of Arts from the University of Kentucky in 1869. He then went to New York where he entered the Bellevue Hospital Medical School from which he was graduated in 1871. Soon after he became associated with the Hospital for the Relief of the Ruptured and Crippled as Assistant Resident Surgeon. This was in the early days of the institution, for that hospital was founded in 1863. It was the only hospital in the country for the treatment of crippled children and for hernia. On the death of Dr. James Knight in 1887, Dr. Gibney was appointed Surgeon-in-Chief of the Hospital for the Ruptured and Crippled; and from that time to his retirement three years ago he continued, not only to direct the medical and surgical departments of the hospital, but to render valuable help in its administration.

Although Dr. Gibney began his surgical career in the pre-antiseptic era, he early recognized the value of Lister's methods. Prior to 1887 the treatment of patients suffering from orthopaedic affections and the treatment of those suffering from hernia in the Hospital for the Ruptured and Crippled consisted almost solely of mechanical appliances. Dr. Gibney quickly recognized that surgery had a distinct place in the treatment of these conditions, and that many cases which before the time of Lister were best treated by mechanical appliances, would show better and more prompt results from operative treatment or a combination of surgical and mechanical methods.

Dr. Gibney was always kind,—always considerate. He was eminently fitted by nature to be an orthopaedic surgeon, because he possessed unusual mechanical skill and that degree of patience that can wait for years for results of treatment. He was an indefatigable worker and blessed with a physical endowment which never tired. He had a remarkable influence over his patients. They all worshipped him and waited eagerly for his daily morning rounds, when his wonderful smile drove away their aches and pains and was often a greater factor in hastening their recovery than was surgical intervention or mechanical appliances.

Generations of house surgeons came and went and each one left with the feeling of great respect for Dr. Gibney's skill, yet with a stronger feeling of friendship and affection for him as a man.

Dr. Gibney is dead, but his memory liveth and will live because he was more than a surgeon. He was a man with greatness in him.

Dr. William Hadden Irish has moved his office to 40 East 41st Street, New York.

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**The Western Surgical Association** will meet at Omaha, Nebraska on December 8 and 9.

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Dr. I. William Nachlas has moved his offices from 2313 Eutaw Place to 1814 Eutaw Place, Baltimore, Md.

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Dr. William S. Baer has recently been appointed Professor of Clinical Orthopaedic Surgery at the Johns Hopkins Medical School.

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The next meeting of the **Clinical Orthopaedic Society** will be held at Memphis, Tenn., on November 9 and 10.

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**The Eastern States Orthopaedic Club** will hold its next meeting in October in Baltimore, Md. Dr. George E. Bennett is arranging the program.

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Dr. Frederick A. Jostes of St. Louis has been appointed Professor of Orthopaedic Surgery in the University of Missouri, at Columbia, Missouri, and Chief Surgeon of the Crippled Children's Service of the University Hospitals.

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Dr. David Silver, who has for many years been interested in the development of the Children's Hospital in Pittsburgh, has been giving much of his time in perfecting the organization of the New Children's Hospital, which was completed in May. He is the acting medical director of this institution.

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The Annual Meeting of the **Seattle Orthopaedic Society** will occur in December. Dr. H. Winnett Orr of Lincoln, Nebraska, is to conduct the clinics and will demonstrate the end result of his treatment for osteomyelitis on several cases upon which he operated when he was in Seattle last summer. All members of the medical profession interested in bone and joint surgery are always welcome at these clinics.

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Dr. Jennings M. King, Jr., who has been resident orthopaedic surgeon at the Children's Hospital during the past year has been elected to the staff of the Pittsburgh Hospital. He will continue as assistant on the staffs of the Children's Hospital and the Pittsburgh Free Dispensary. He has been appointed instructor in the University of Pittsburgh.

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**The American Red Cross** will conduct its annual nation-wide Roll Call, to enroll members for the year 1928, from Armistice Day, November 11, through Thanksgiving Day, November 24, 1927.

The American Red Cross, with a membership of more than three millions and an additional Junior membership of six millions, has become the recognized agency of the American people for extending service to humanity. Its work is supported through the membership dues secured once a year during the Roll Call.

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## THE ANNUAL MEETING OF THE AMERICAN ORTHOPAEDIC ASSOCIATION

*Reported by Dr. Robert B. Osgood, Boston*

The Orthopaedic Special left its eastern terminus at Boston on June 4, and, picking up more and more of the faithful along the way, bore them with great comfort and without serious delays to the Grand Canyon of the Colorado in Arizona.

After two days of marvel at the Grand Canyon, the company moved on to Pasadena,

arriving just after luncheon on June 11. They were welcomed heartily at the station by the Los Angeles Orthopaedic Club headed by Dr. John C. Wilson. The members and guests and their families were driven to the beautiful Hotel Huntington. A word of gratitude to the agent of the Sante Fe Railway, who accompanied the Special from Chicago, should be here said. Courtesy and helpfulness seemed to be his motto.

The program of the first clinical session held in the ballroom of the Huntington Hotel was as follows:

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| Drs. Lowman, Schott, Barnard and Young | Twelve assorted cases. |
| Dr. Steele F. Stewart | Six cases of ramisection. |
| Dr. John C. Wilson | Extra-articular fusion of the tuberculous hip joint in children. |
| Dr. Wm. Arthur Clark | Three foot cases. |
| Dr. John Dunlop | Foot cases. |
| Dr. Alfred E. Gallant | Three bone grafts of the spine. |
| Dr. H. Waldo Spiers | Two cases. |
| Dr. E. N. Reid | One case. |
| Dr. Richard Pyles | Three cases. |
| Dr. Walter C. S. Koebig | Back cases. |
| Dr. A. Gottlieb | Foot cases. |
| Dr. H. W. Chappel | Six cases of osteomyelitis. |

No one could fail to be impressed by the abundance of material, the thoroughness with which this material had been worked up, the success obtained when the problems had been visualized, and the frankness of the presentations. Some one had made a team and imbued it with spirit.

The entire group of visiting surgeons and their families was lavishly entertained in the evening, before a very delicious dinner, by an exhibition of swimming in the lighted pool in the garden of the hotel, and afterwards by a group of Spanish players. In the after-dinner speech of Dr. Clarence G. Toland, an eminent general surgeon of Los Angeles a very graceful tribute was paid to the energy and remarkable accomplishments of the orthopaedic surgeons of Los Angeles. On Saturday, June 12, an opportunity was afforded the members and guests to visit Hollywood and see a "close up" of the moving-picture industry.

In the late afternoon the company entrained for the Yosemite and by Sunday afternoon were housed in the extremely comfortable cabins of Camp Curry. A part of the large dance hall served excellently for the scientific and executive sessions, which were opened promptly on Monday morning by Dr. James T. Watkins. His Presidential Address was a very remarkable one and made a strong appeal by its erudition and idealism. The program follows:

FIRST SESSION

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| 1. President's Address | James T. Watkins, M.D., San Francisco, Calif. |
| 2. James O. Wallace, M.D., Pittsburgh, Pa. | Arthrotomies of the Knee Joint.<br>Discussion: Mark H. Rogers, Boston., J. Torrance Rugh, Philadelphia, and Robert B. Cofield, Cincinnati. |
| 3. M. S. Henderson, M.D., Mayo Clinic, Rochester, Minn. | Tuberculosis of the Knee in the Adult.<br>Discussion: Fred H. Albee, New York City, and Charles F. Eikenbary, Spokane, Wash. |
| 4. F. C. Kidner, M.D., and Felipe Muro, M.D., Detroit, Mich. | End Results in Treatment of Pott's Disease With and Without Hibbs' Fixation Operation. Illustrated with moving pictures, from the Orthopaedic Clinic of the Children's Hospital of Michigan.<br>Discussion: John L. Porter, Chicago and Samuel Kleinberg, New York City. |

5. Rodney F. Atsatt, M.D., Santa Barbara, Calif. By invitation.
   A Quantitative Tuberculin Reaction in Bone and Joint Diagnosis (Preliminary Report).
   Discussion: F. C. Kidner, Detroit, Robert B. Osgood, Boston, and Walter Stern, Cleveland.
6. C. F. Eikenbary, M.D., Seattle, Wash.
   A Further Report on a Hitherto Undescribed Dystrophy. First report published in the American Journal of Orthopaedic Surgery, April, 1915.
   Discussion: Arthur Steindler, Iowa City, and J. E. Stewart, St. Louis.
7. Executive Session.

SECOND SESSION

1. Fred H. Albee, M.D., New York City.
   End Results in 145 Cases of Ununited Fractures of the Neck of the Femur.
   Discussion: M. S. Henderson, Rochester, Minn., Ellis W. Jones, Los Angeles, and George E. Bennett, Baltimore.
2. Roscoe N. Gray, M.D., San Francisco, Calif. By invitation.
   Statistical Study of Disability and Cost of Industrial Fractures.
   Discussion: James O. Wallace, Pittsburgh, J. S. Speed, Memphis, and Ellis Jones, Los Angeles.
3. Walter Stern, M.D., Cleveland, O.
   Conservative Treatment of Compound Fractures.
   Discussion: H. Winnett Orr, Lincoln, Neb., Robert Schrock, Omaha, Neb., and Mitchell Langworthy, Spokane.
4. H. D. Corbusier, M.D., Plainfield, N. J. By invitation (Absent) Presented by title.
   Physiotherapy in its Application to Orthopaedic Cases.
5. Charles LeRoy Lowman, M.D., Los Angeles, Calif.
   Traction and Fusion in the Treatment of Scoliosis. Illustrated with slides.
   Discussion: Samuel Kleinberg, New York City, and Walter Truslow, Brooklyn.
6. Mark H. Rogers, M.D., Boston, Mass.
   The Formation of Rice Bodies in Tuberculosis.
   Discussion: William E. Blodgett, Detroit, and William A. Clark, Pasadena.

THIRD SESSION

1. H. Winnett Orr, M.D., Lincoln, Neb.
   The Treatment of Acute Osteomyelitis by Drainage and Rest.
   Discussion: Ellis Jones, Los Angeles, and Frederick J. Gaenslen, Milwaukee.
2. Robert McE. Schauffler, M.D., Kansas City, Mo.
   Recurrent Multiple Osteomyelitis Due to Staphylococcus Aureus.
   Discussion: W. E. Blodgett, Detroit, and J. S. Speed, Memphis.
3. Clarence L. Starr, M.D., Toronto, Canada (Absent) Presented by title.
   Fracture of the Spine with Special Consideration of Ultimate Function.
4. Mark H. Rogers, M.D., Boston, Mass.
   The Principles of Teaching Orthopaedic Surgery.
   Discussion: DeForest P. Willard, Philadelphia, and George E. Bennett, Baltimore.

**FOURTH SESSION**

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| 1. Rea Smith, M.D., Los Angeles, Calif. By invitation. | The Relation of the Surgical Pathology of the Right Lower Quadrant to Arthritis. Discussion: Ellis W. Jones, Los Angeles, and Mark H. Rogers, Boston. |
| 2. R. G. Taylor, M.D., Los Angeles, Calif. By invitation. | Demonstration by X-ray Examination of Surgical Pathology of the Right Lower Quadrant Found in Arthritis. Discussion: Mark H. Rogers, Boston. |
| 3. Arthur L. Fisher, M.D., San Francisco, Calif. By invitation. | Certain Considerations of Second Type Arthritis as Exemplified in the Shoulder Joint. Discussion: John L. Porter, Evanston, and Robert B. Osgood, Boston. |
| 4. Steele F. Stewart, M.D., Los Angeles, Calif. By invitation. | End Results of Ramisection in Spastic Paralysis. Lantern slides and moving pictures. Discussion: J. E. Stewart, St. Louis, and Thomas A. Stoddard, San Francisco. |
| 5. Professor Ernest G. Martin, Department of Physiology, Stanford University, Calif. By invitation. | Physiology of Muscle Innervation with Special Reference to Sympathetic Control. Discussion: H. Winnett Orr, Lincoln, and E. A. Rich, Tacoma. |
| 6. Robert B. Osgood, M.D., Boston, Mass. | Certain Etiologic Factors in Cases of So Called Scoliosis. Discussion: Walter Truslow, Brooklyn; Charles L. Lowman, Los Angeles, and John C. Wilson, Los Angeles. |

**FIFTH SESSION**

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| 1. Arthur Steindler, M.D., Iowa City, Iowa. | Surgery of the Upper Extremity. Lantern slides. Discussion: Leo Mayer, New York City, and John C. Wilson, Los Angeles. |
| 2. Sterling Bunnell, M.D., San Francisco, Calif. By invitation. | Reconstruction of the Nerves and Tendons of the Hand. Discussion: Leo Mayer, New York City, and Arthur Steindler, Iowa City. |
| 3. Leo Mayer, M.D., New York City. | Transplantation of the Trapezius for Paralysis of the Deltoid Muscle. Discussion: Sterling Bunnell, San Francisco; and Arthur Steindler, Iowa City. |
| 4. James S. Speed, M.D., Memphis, Tenn. | End Results of the Transference of the Crest of the Ilium (for Flexion Contracture of the Hip). Motion picture cartoon of the Operation, slides and moving pictures of Pre-operative and Postoperative Cases. Discussion: M. S. Henderson, Rochester, Minn.; Frank D. Dickson, Kansas City, Mo., and Leo Mayer, New York City. |
| 5. M. S. Henderson, M.D., and George E. Brown, M.D., Mayo Clinic, Rochester, Minn. | Circulatory Disturbances of the Extremity. Discussion: Walter Stern, Cleveland. |

The Program Committee deserve great praise for preparing and presenting a series of papers of such importance, timeliness and interest. Despite the beauties of the wonderful valley and the insistent "call of the great outdoors", there was a constant large audience of about one hundred and fifty members and guests at all of the five half-day

sessions and it was often necessary for the presiding officer to limit discussion in order to make it possible for the program to be completed.

It would be invidious to select for special comment any of the papers of the members, but we may at least extend warmest thanks to the readers of papers by invitation. The presentation of Dr. Rea Smith and Dr. R. G. Taylor of Los Angeles on the relation of intestinal stasis to arthritis, the discussion of the physiology of the sympathetic nervous system by Professor Ernest G. Martin of Leland Stanford, and the paper of Dr. Steele F. Stewart on the results of a large series of ramisections for spastic paralysis were of enormous value. Dr. Sterling Bunnell of San Francisco demonstrated by lantern slides his methods of tendon and nerve suture. The results which his preeminent skill and exquisite technique had made possible were almost unbelievably perfect. Dr. Rodney F. Atsatt of Santa Barbara has given us a more reliable and sensitive method of determining the presence of active tuberculous bone and joint lesions. The contribution of Dr. Roscoe N. Gray of the Aetna Insurance Company is of far-reaching importance to all industrial surgeons, insurance companies and workingmen's compensation commissions. Dr. Arthur L. Fisher of San Francisco gave an interesting pathological demonstration by specimens and lantern slides of the early cavity formation in the ends of the bones in cases of second type arthritis; he and Dr. Leonard Ely look upon these cavities as probably the earliest changes in this type and believe them to be, therefore, of important diagnostic significance.

Wednesday, June 15, had been wisely set aside as a holiday and this made possible excursions to the Big Trees at Mariposa Grove, Glacier Point, and the gorgeous waterfalls which tumble into the Valley.

After the session on Thursday, June 16, the party traveled either by day or night on Friday to San Francisco, arriving in time for the clinical program which follows, presented by the San Francisco group headed by the president, Dr. James T. Watkins, and held at the beautiful new building of the County Medical Society.

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| 1. James T. Watkins | a. An appliance for treatment of stiff fingers. |
| | b. Plastic operations on the hips. |
| 2. George J. McChesney | a. Deutschlander's disease. |
| 3. Lionel D. Prince | a. Reconstruction of the hip. |
| | b. Vertical fractures of the astragalus. |
| 4. E. W. Cleary | a. Fusion operation for fractured spine. |
| 5. S. L. Haas | a. Operative result after double congenital dislocation of the hip with double talipes equinus varus. |
| | b. Sprengel's deformity. |
| 6. Edward C. Bull | a. Arthroplasty of the hip. |
| | b. Back-knee. |
| 7. Arthur L. Fisher | a. Case demonstration of emetin treatment of arthritis. |
| 8. Howard H. Markel | a. Manufacture of a thumb. |
| | b. Excision of sacralized fifth lumbar transverse process. |
| 9. F. A. Lowe | a. Fracture of neck of radius. |
| 10. L. Eloesser | a. Juxta-articular tubercular sequestra. |

DEMONSTRATIONS TO SMALL GROUPS

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| 1. Sterling Bunnell | a. Operations on tendons and nerves of the hand (Cadaver demonstration). |
| 2. W. L. Bell | a. Demonstration of orthopaedic table. |
| | b. Bone plates and screws. |
| 3. Rudolph L. Dresel | a. Fracture bed. |
| 4. L. Eloesser | a. Apparatus for treatment of fractures of the femoral neck. |

The openhanded and openhearted hospitality of Los Angeles was repeated in San Francisco and after the clinical morning was over, the members and guests were entertained at luncheon and taken in luxurious busses for a tour of the city and its beautiful parks. They were then given a most unique, delicious (and digestible) dinner at a Chinese restaurant in Chinatown and taken afterwards to a Chinese theatre. The evident happiness of our hosts in being able to give pleasure saved us from being embarrassed by their kindness.

The first western meeting may be said to have been an unqualified success, scientifically, socially and scenically. It is surely true that the members, who in spite of the long journey overcame their eastern insularity, will be eager to have a chance to overcome it again. They have learned how far the West can lead us and how close is the spirit of common effort and good fellowship which binds us together.

# Current Literature

FRAKTUREN UND LUXATIONEN. EIN KURZGEFASSTES LEHRBUCH FÜR ÄRZTE UND STUDIERENDE. By K. H. Bauer. Berlin, Julius Springer, 1927.

This book is what it purports to be, — a text-book for physicians and students. It is scholarly, but only thorough in parts.

The general part is excellent reading for any one interested in bone lesions. The illustrations are well chosen and are chiefly adequate radiographic reproductions of the usual traumatic bone and joint lesions. In the provisional treatment of recent fractures one seeks in vain for mention of the efficient Thomas splint. The author also fails to allude to the advantages of reduction with fluoroscopic aid.

In that part of the book devoted to special fractures we, in America, would note many omissions, — for instance, the *Whitman* method in fractures of the femoral neck, the work of *Cotton* in fractures of the os calcis, the *Davis* method in reduction of the carpal semilunar, the *Sinclair* skate. In fractures of the spine associated with paralysis, the author is favorably inclined towards laminectomy (in selected cases).

Nevertheless, it is a good book and to be recommended to those who read German.

SARGENT, DUDLEY ALLEN, AN AUTOBIOGRAPHY. By Ledyard W. Sargent with an introduction by R. Tate Mackenzie, M.D., Philadelphia, Lea and Febiger, 1927.

Dr. D. Allen Sargent's work is so well known in the field of physical education in this country that this autobiography will doubtless find its way into many homes. Dr. D. Allen Sargent was one of the earliest pioneers in physical education in the United States. A native of Belfast, Maine, he opens his life's study with his early boyhood days spent in Belfast. At the age of seven after the death of his father, the lad went to Hingham for three years, returning to his native town of Belfast when he was ten or eleven years of age to live with his widowed mother.

He explains that the restlessness of the Civil War period caused him to leave school when he was thirteen years old and he tells in detail of his first job. The lad did a man's work with pick, shovel, wheel barrow and a heavy wooden maul, for which he was paid a man's wages, $1.50 a day. His next step was to board the "Moses Eddy". He tells of how he "scented the salt sea in his nostrils and heard the deep sea calling him" although having a wholesome and inherent dread of its unknown portent. Seven weeks of actual sea-going completely cured his inclination to follow the sea as his life's work, although he claims that the experience was of important value to him in later life.

Young Sargent returned to school when he was fifteen years of age, working meantime at odd jobs to help support himself. Owing to the boy's natural athletic tendencies, he became a leader in physical stunts that balked other boys in the school. The horizontal bar, free back swing, was considered one of his greatest physical accomplishments. From this physical prowess, his skill attracted a wider recognition than that of his school. His uncle used to invite friends from out-of-town to see the feats done by his nephew and a group of young friends, of whom Sargent seems to have been the leader, give exhibits and public performances including singing, dancing, instrumental and dramatic sketches; the group was styled the "Sargent combination". From these amateur performances, the young gymnast next entered activities as a professional circus gymnast and travelled with a circus company from place to place.

We follow the boy's career in his various boyhood inclinations to his first real step on the ladder of his life's work, that of Director of Gymnastics at Bowdoin College. Here at the age of twenty, Sargent organized his physical training class and started

teaching. Bowdoin College was among the first of American colleges to recognize daily attendance at the gymnasium for each student in the college, and later classes were graded for hours spent in this department.

Yale University was Sargent's next step and for six years he was director of the gymnasium, studying meantime, until 1875 when he entered the Yale Medical School. He was graduated with his M.D. in 1878. Hoping that this degree would carry weight and so help him to make it possible to start departments of physical education for college men, Sargent tried to get those in charge of affairs at Yale to establish a Department of Physical Education. Failing to get the necessary appropriations to establish such a department, although obtaining the support and interest of a committee, he wrote to ten or twelve college presidents in different parts of the country proposing new departments of physical education for their institutions. He was doomed to disappointment and although the responses from the different college heads were polite, not one was willing to go ahead with Sargent's plan.

Dr. Sargent next opened his own Institution of Hygiene and of Physical Education in New York City on Fifth Avenue and 24th Street; here he taught exercises to men, women and children, and a teachers' course in physical education was also established. Dr. Sargent accepted his first appointment as director of the Hemenway Gymnasium and Assistant Professor of Physical Education in September 1879.

In January 1880 Dr. Sargent started his first season at Harvard College. His summer courses proved to be so successful from a financial point of view that a variety of courses under the auspices of the Harvard Athletic Association were arranged.

To quote, statistics show that, "Beginning with fifty pupils and some dozen instructors and student assistants, it has increased steadily in size until, before the War, there were 230 pupils, 48 lecturers and assistants. From 1887 to 1918 the total registration at the Summer School was 4269. Of this number there were 3052 individuals, many of whom registered several different years. The School represents 1082 institutions of which 53 are in foreign countries, it includes 232 colleges, 245 secondary schools, 65 normal schools, 326 public schools, 11 normal schools of physical education, 52 Y.M.C.A. gymnasiums, 30 athletic clubs, 27 state institutions and 4 vocal training schools. Every state in the Union is represented. No course is more democratic, more broadening or more heterogeneous in the character, experience and ambitions of its personnel."

A Clinical and Statistical Study of Chronic Arthritis Based on Eleven Hundred Cases. Ralph Pemberton and E. G. Pierce. *Am. J. Med. Sc.* CLXXIII, 31, 1927.

Clinical observations on 700 cases in civil life are compared with similar observations on 400 cases among soldiers. In civil life the onset was gradual in more than half of the cases and the knee was the site of most frequent involvement in all groups of both sexes. Foci of infection were present in about seventy per cent. of both groups but in 100 consecutive cases of disease at large admitted to the medical service of the Presbyterian Hospital, Philadelphia, more than eighty-seven per cent. had active foci of infection. Neoplasms, active tuberculosis, and diabetes were very rare in chronic arthritics. The blood pressure tended to be normal or low among arthritics and the disease was often associated with a secondary anaemia.

Prognosis is good in all types of arthritis. Seventy-three per cent. of the civilian cases were definitely improved and of these one-third recovered completely. Only nine per cent. in the civilian group and four per cent. in the army group were unimproved. The proliferative arthritis responded better to treatment than did the degenerative. —*J. A. Key, M.D., St. Louis, Mo.*

A Clinical and Roentgenologic Study of High Colonic Irrigations as used in the Therapy of Subacute and Chronic Arthritis. R. G. Snyder and S. Fineman. *Am. J. Roentgenol.*, XVII, 27, Jan. 1927.

Emphasizing the frequent multiplicity of causes in the production of arthritis,

Snyder believes that in refractory cases, after exhausting treatment of determined foci of infection, or failing to discover any foci, the poor therapeutic results are probably due to existence of infective foci or to toxic absorption in the genito-urinary and intestinal tracts. He feels that the genito-urinary tract has not received adequate attention. As to the colon, in spite of the absence of proof that stasis and infection here will produce chronic arthritis he has empirically used in the past four years, wherever clinically indicated, a system of treatment aiming at elimination and correction of intestinal stasis, —this in addition to other accepted treatment. Since doing so, his clinical results have shown a definite improvement. He does not feel that the colon is a factor in all cases, no doubt in many cases it has no relation to the onset. By *high irrigation* is meant the insertion of a fifty-four inch or longer "Lockwood tube" passing into the colon as far as the splenic flexure or into the more proximal portions of it, as far as the caecum. Proper technique is of the greatest importance, and only by reference to the original article can this be understood. Only by x-ray can it be demonstrated that the tube has reached within the colon, and as this check was not feasible in all cases the authors cannot claim that all the benefit of the procedures in their cases was due to use of the high tube. A minimum course of twenty to thirty irrigations is insisted on; from two to four gallons each time; fresh cultures of B. acidophilus are injected into the colon after each irrigation.

"No implication is made that colonic irrigations are a specific cure for subacute and chronic arthritis. . . . . The improved clinical results, it would seem, should be attributed to the system of irrigations as a whole."

The article, of sixteen pages, includes a discussion which indicates that such procedure is work for the expert only.—*Roades Fayerweather, M.D., Baltimore, Md.*

Bone Diseases in Infancy and Childhood. E. L. Jenkinson and Philip Lewin. *Am. J. Roentgenol.*, XVII, 201, Feb. 1927

The feature of this paper is the extensive "Differential Diagnostic Chart" in which are compared in parallel columns the characteristics of the following conditions: rickets; scurvy; syphilis; tuberculosis; epiphysitis; osteochondritis; osteomyelitis; osteogenesis imperfecta; achondroplasia; Still's disease; marble bones; cretinism; multiple cartilaginous exostoses; multiple myeloma; coxa vara; haemophilia; coccidioidal granuloma. Comparisons are made with regard to the following: history; age; epiphyses; epiphyseal line; diaphyseal line; shaft; medulla; cortex; periosteum; joint; atrophy; fractures; deformities; special remarks; treatment; prognosis.

Although intended chiefly as a guide to x-ray interpretation, the inclusion of various clinical and historical points indicates the impossibility of x-ray diagnosis from radiographic study alone.

It is inevitable that in a tabulation such as this a number of important features should receive no mention, and that among the characteristics noted some should be included about which observers differ, particularly in the matter of treatment. On the whole, however, the paper presents a very useful review of a number of pathological conditions that must frequently be submitted to comparison in differential diagnostic studies.—*Roades Fayerweather, M.D., Baltimore, Md.*

The Principles Underlying the Rational Treatment of Acute Osteomyelitis. A. O. Wilensky. *Ann. Surg.* LXXXV, 428, Mar. 1927.

The anatomical and pathological conditions are discussed. The treatment is divided into (1) the bacteriemia and (2) the local lesion.

(1) The number of colonies of bacteria per c.c. of blood which develop on a plate from a blood culture is taken as a rough estimate of the severity of the bacteriemia. Cases are divided into:

A. Those where no treatment is required for the general condition.

B. The fulminating, progressive, and severe form of bacteriemia. The local lesion plays a minor rôle. The duration of the illness is often a question of a few days.

C. The intermediate cases between A and B.

(2) Treatment of the local lesion:

A. In the absence of a demonstrable bacteriemia the local lesion is drained; thereafter one should wait until the full demarcation of the sequestrum has occurred.

B. In the presence of bacteriemia the local focus should be removed as early and as completely as possible.—*F. G. Hodgson, M.D., Atlanta, Ga.*

CHRONIC STRAIN OF THE LUMBAR SPINE AND SACRO-ILIAC JOINTS. John B. Carnett. *Ann. Surg.* LXXXV, 509, Apr. 1927.

Tenderness is obtained by deep pressure over the intra-abdominal vertebrae. He considers this chronic mid-line tenderness due to "chronic sprain" of the vertebral joints caused by exaggerated lumbar lordosis and postural stress. It is analogous to the breaking down of the arches of the feet. There is tenderness also over the superior aspect of the sacro-iliac joint in the iliac fossa. This tenderness may be mistaken for appendicitis, or ureteral conditions. In cases under consideration the tenderness is usually bilateral. The lordosis in the lumbar region is commonly associated with a variable degree of compensatory kyphosis (round shoulders) in the thoracic region. These cases complain of backache and neuralgic pains referred to the twelfth dorsal and first lumbar nerves chiefly. The ideal treatment is prevention or early correction of the excess lordosis by corrective muscular exercises. In acute cases rest in bed and removal of toxic foci are indicated. Sometimes a spinal support is necessary.—*F. G. Hodgson, M.D., Atlanta, Ga.*

FRACTURES OF THE TRANSVERSE PROCESSES OF LUMBAR VERTEBRAE. Robert H. Kennedy. *Ann. Surg.* LXXXV, 519, Apr. 1927.

Etiology is direct violence or muscular strain. Severe pain and tenderness in lumbar region. Comfortable when lying down, but pain on turning. No nerve involvement. Diagnosis confirmed by x-ray. Bony anomalies and old injuries should be taken into consideration.

Prognosis: If the patient does not know of the fracture or there is no question of compensation he should recover just as from an ordinary bruise or muscle injury.

Treatment: Rest in bed during acute pain. Adhesive plaster strapping. Physiotherapy as soon as acute pain subsides. A report of ten cases is given.

Results: Disability varied from fifteen days to six months. The majority of cases should be able to be at work within two months.—*F. G. Hodgson, M.D., Atlanta, Ga.*

THE USE OF THE RUSSELL APPARATUS IN THE TREATMENT OF FRACTURE OF THE SHAFT OF THE FEMUR. Thomas J. Ryan. *Ann. Surg.* LXXXV, 529, Apr. 1927.

This simple traction method is described. The anatomy of the thigh and the physiology of muscles and new bone formation is discussed. The mechanics of this method is figured. The writer reports eight cases. He concludes that this simple method is very satisfactory in certain cases. It is very comfortable and the period of disability is shortened.—*F. G. Hodgson, M.D., Atlanta, Ga.*

THE REPAIR OF INJURIES TO THE POSTERIOR CRUCIAL LIGAMENT OF THE KNEE JOINT. William E. Gallie and A. B. Le Mesurier. *Ann. Surg.* LXXXV, 592, Apr. 1927.

The rupture or stretching of the posterior crucial ligament is a very disabling condition, and the patient must either wear a heavy apparatus or suffer from an unstable and often painful knee. The operation consists of a long median posterior incision and isolation of the semitendinosus and utilizing its distal portion. The posterior capsule of the knee joint is exposed. A quarter-inch hole is drilled through the head of tibia coming out near insertion of the semitendinosus. An anterior mid-line incision is made to enter the knee joint by the split patella route. The semitendinosus tendon is isolated and passed through the head of the tibia from before backward. The interior of the

joint is exposed, the new ligament is pushed through the posterior capsule in the line of the posterior crucial. A hole is now drilled through the internal condyle and the new ligament fastened so that it is entirely subsynovial. Knee is kept in extension in plaster two months. A case is reported one year after operation with excellent function. This is another brilliant contribution by these two excellent Toronto surgeons.—*F. G. Hodgson, M.D., Atlanta, Ga.*

KOEHLER'S METATARSOPHALANGEAL DISEASE. Klaus von Dittrich. *Arch. f. Orthop. u. Unfall-Chir.*, XXIV, 454, 1927.

Trauma is given as the actual cause of this affection. The anatomical changes in the foot such as splay-foot or metatarsal flatness are to be regarded as conditions favorable toward the development of the epiphyseal bone-cartilage degenerations. The second as well as the third metatarsal heads are thus exposed to counterpressure of the ground. The predominance of this affection in women is explained on the same bases as the more frequent occurrence of other foot deformities in the female sex. Pes valgus, pes planus, halux valgus, etc., are all more frequent in women than in men due, possibly, to an inherent weakness of the musculoligamentous structures in women and to the wearing of unphysiological footgear.

The microscopical findings offer sufficient proof that the affection is of traumatic origin. The assumption of a mycotic-embolic closure of the vessel wall, seems improbable on the ground of investigations of the author. He could not locate such pathological obstruction in the vessels by a series of sections of the involved epiphysis. Only such findings could prove the thrombus theory of Axhausen.—*A. Gottlieb, M.D., Los Angeles, Calif.*

TUBERCULOUS TENOVAGINITIS AND BURSITIS AFTER INJURY. F. Zollinger. *Arch. f. Orthop. u. Unfall-Chir.*, XXIV, 456, 1927.

Tuberculous bursitis is very frequently and tuberculous tenosynovitis is in most instances a secondary manifestation; the primary focus is to be found in a neighboring bone or joint. Both conditions are infrequently to be regarded as a sequence of trauma only; trauma aggravates a preexisting disease or effects the localization of bacilli from a neighboring focus. Even the fact that the patient was not incapacitated does not prove that tenosynovitis and bursitis did not exist, since in a mild form they may be symptomless and not disabling.

The appearance of tuberculous bursitis may be attributed to a skin lesion, while tenosynovitis requires for its development an injury to the tendon sheath itself. Subcutaneous injuries may be regarded as etiological factors if they have considerably damaged the respective tissues. A mild lesion does not suffice. If the tuberculous bursitis or tenosynovitis manifests itself as early as a few days after the injury, it is certain that the disease preexisted and that the trauma was only a contributing factor. If, however, the affection presents itself only six months later, and if definite signs of chronic inflammation, especially long lasting swelling, are demonstrable it may be regarded as having resulted from the injury.—*A. Gottlieb, M.D., Los Angeles, Calif.*

A NEW PROCEDURE FOR ARTHRODESIS OF THE SHOULDER JOINT. Michael Friedland. *Archiv. f. Orthop. u. Unfall-Chir.* XXV, 156, June 15, 1927.

Through a vertical subacromial incision the joint is opened. The long tendon of the biceps is retracted and the head of the humerus dislocated. In the glenoid cavity a round hole is bored which extends deep into the bone substance and is of the largest possible width; a corresponding shape is given to the head of the humerus after it is bared of articulating cartilage. After that the newly shaped head is fitted into the hole of the glenoid fossa, so that the arm is held in about sixty-five degrees of abduction and slight inward rotation; in this position the arm is immobilized in a plaster-of-Paris cast.

The author named this operation "luxation humeri centralis artificialis" and advocates such a procedure in hip arthrodesis as well.—*A. Gottlieb, M.D., Los Angeles, Calif.*

FAT EMBOLISM: INCLUDING EXPERIMENTAL PRODUCTION WITHOUT TRAUMA. Edwin P. Lehman and Robert M. Moore. *Arch. Surg.*, XIV, 621, Mar. 1927.

Trauma, particularly of bone marrow, has been generally blamed for fat embolism. This paper calls attention to another source of fat-producing capillary occlusion, namely the emulsion of fat in normal blood plasma. Attention is drawn to the fact that fat is present in blood in appreciable quantities, particularly after meals containing much fat, and that this fat exists as ultra-microscopic globules suspended in the plasma in the nature of a colloid. As in other colloids, alteration in surface tension and change of the interphase may break down such an emulsion. To this end experiments are conducted to prove that necrotic tissue products, various poisons and toxins, and particularly ether anaesthesia may be factors *per se* in fusion of the globules to a size such that embolism may result. These experiments, while far from being conclusive, are quite suggestive and interesting.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

COALITION OF THE CALCANEUS AND THE NAVICULAR. Carl E. Badgley. *Arch. Surg.* XV, 75. July 1927.

Rigid flat-foot will at times be found to be the result of coalition between the anterior process of the calcaneum and the tarsal navicular. It is explained that in about one per cent. of 840 skeletons examined, an accessory calcaneum, the calcaneum secundarius, was present. This bone may fuse with the calcaneum, the lower surface of the navicular, or with both, resulting in partial or total ankylosis between these bones. The resulting rigid foot is generally in valgus, usually produces symptoms of flat-foot at the age of puberty, and is associated with spastic peroneals. X-ray of the foot taken obliquely will show the bony bridge. Five cases are reported.— *I. Wm. Nachlas, M.D., Baltimore, Md.*

DEPOSITION OF CALCIUM SALTS IN AREAS OF CALCIFICATION. James C. Watt. *Arch. Surg.* XV, 89, July 1927.

Continuing his observations on the formation of bony deposits, Watt reports his microscopic studies of pathological areas of calcification in the pineal gland, choroid plexus, thyroid gland, and arterial walls. In none of the specimens examined could any cellular membrane be found near the bony depositions, nor are any osteoblastic cells found in or near these deposits. The deduction is therefore made that no cellular activity takes place in the formation of these calcaneous masses. Calcification must, therefore, be produced by precipitation and Klotz's theory is offered as the most plausible explanation of the mechanism involved. The soluble sodium and potassium salts react with the fatty acids in necrotic areas to form soaps. These are precipitated by the soluble calcium salts to form insoluble calcium soaps. Gradually the phosphates and carbonates of the blood replace the organic radicals to form bone. This theory would explain the morphological and staining properties of the precipitates studied.— *I. Wm. Nachlas, M.D., Baltimore, Md.*

HYPERTROPHIC ARTHRITIS OF THE SPINE. Its Incidence and Nature in Patients More Than Fifty Years Old. John D. Garvin. *Arch. Surg.* XV, 118, July 1927.

The occurrence of "incidental hypertrophic arthritis" in 2090 patients over fifty years of age, and a detailed analysis of 500 of these cases are presented. By "incidental" arthritis is meant the arthritic involvement recognized on x-ray films taken in the study of non-skeletal tracts, chiefly the genito-urinary tract. It is interesting to note that approximately seventy per cent. of the patients studied had no complaints referable to the arthritic findings. In most of the patients there were found, alone or combined, foci of infection, chronic traumata, and senescent changes. In conclusion, Garvin warns against radicalism in the treatment of hypertrophic arthritis of the spine in persons over fifty years of age.— *I. Wm. Nachlas, M.D., Baltimore, Md.*

EXPERIMENTAL OBSERVATIONS ON THE GROWTH OF LONG BONES. Gatewood and Bernard P. Mullen. *Arch. Surg.* XV, 215, Aug. 1927.

By imbedding shot at definite distances in the femora of young rabbits, and studying x-ray films made at various intervals, the authors were able to localize the growing portions of the bones. Their findings lead them to the conclusion that no longitudinal growth takes place in the diaphyses. They also note that destruction of the extrinsic blood supply to an epiphysis will hasten the closure of that epiphysis, and that immediate closure will result from destruction of the epiphyseal cartilage plate on the side nearest the joint.— *I. Wm. Nachlas, M.D., Baltimore, Md.*

PARAPLEGIA ASSOCIATED WITH CONGENITAL SCOLIOSIS. Kenneth G. McKenzie. With Comments by Clarence L. Starr. *Arch. Surg.* XV, 222, Aug. 1927.

McKenzie reports a case of congenital scoliosis associated with paraplegia in a boy aged eighteen. Since Bradford-frame treatment gave no relief, laminectomy was performed. The cord was found compressed where the dural sac was drawn taut over the bony convexity. Opening of the dura permitted the cord to bulge outward, with apparent relief of pressure. Following the operation, the paralytic phenomena rapidly cleared up.

In commenting on this case, Dr. Starr calls attention to the rarity of congenital scoliosis with late symptoms of paralysis, citing the five cases reported in the literature. — *I. Wm. Nachlas, M.D., Baltimore, Md.*

AVULSION FRACTURE OF THE OS CALCIS. Harold G. Lee. *Boston Med. and Surg. J.* CXCVI, 1000, June 16, 1927.

Avulsion fracture of the os calcis, that is, the tearing away of the upper portion of the os calcis by action of the gastrocnemius-soleus muscles acting through the tendo Achillis, is a very rare lesion. Lee reports a case, with the treatment employed.

While leaning over, the patient, a heavy woman, lost her balance and fell. She suffered immediate pain in the left heel with inability to rise. Roentgenograms showed an avulsion fracture of the os calcis. Open reduction was advised and performed. At operation two lateral incisions exposed the broken fragment and the body of the os calcis. Chromic catgut sutures, No. 2, were passed through a drill-hole in the os calcis, and over the approximated fragment. These were tightly tied, holding the fracture in perfect position. The wounds were closed without drainage, and a plaster cast applied from toes to groin. X-rays taken five days after reduction showed perfect apposition. The cast was worn for three months, weight-bearing being allowed the latter portion of this time. At the end of six months bony union was complete, and the patient could walk up and down stairs without pain.—*Henry W. Lamb, M.D., Portland, Maine.*

TREATMENT OF ANKLE SPRAINS. Charles P. Hutchins. *Boston Med. and Surg. J.* CXCVII, 91, July 21, 1927.

In his article on ankle sprains, Hutchins first inventories the pathological possibilities, that is, the extent to which ligaments and tendons may be involved without fracture or dislocation of bone.

Sprain of the ankle is most often caused by unguarded movement, by which the foot is turned suddenly inward (rarely outward), with sufficient force to rupture the ligaments, and possibly some of the fibres of the muscles, and to strain the tendons and sheaths.

An anatomical consideration is presented by the author to demonstrate that eversion sprains are much less common, due to the arrangement of structures about the ankle joint. He states, too, that when the foot is at a right angle to the lower leg, or when dorsally flexed to a lesser angle than that, sprains at the ankle joint are rare.

Treatment consists of strapping, the following technique being that employed by Hutchins.

"The patient is seated upon a table at such a level that his depending foot hangs six or eight inches lower than the knee of the operator, who sits facing him. With adhesive straps one and one-half inches wide cut to length, the patient's foot is placed upon the operator's knee so that the ankle is dorsally flexed to eighty or eighty-five degrees from the long axis of the tibia and rests the full weight of the extremity upon the head of the fifth metatarsal. The patient's leg must be wholly passive. This leaves the leg on straight alignment from hip to ankle joint, and throws the foot into slight eversion. The first strap runs spirally around the lower calf on the medial side, across the instep and cuboid, under the sole, falling into a natural sweep on the dorsum. This is the salient control of the hypermobility. The second strap is a counterpart in the opposite direction, acting to limit eversion, and balancing the first. The third support is a stirrup from the middle of the calf, and passes in the lateral plane of the ankle joint. The fourth and narrow strip retains the third support in contact with the leg at its isthmus above the malleoli. It is imperative that the patient's leg be maintained in the same posture throughout the dressing, and his muscle action inhibited."

When the joint is firmly held by support, the patient is encouraged to walk; for functional use, if it does not cause further injury, is the best stimulant to repair. When the angle between the foot and the lower leg exceeds ninety degrees, the plaster is changed. Diathermy is used in conjunction with the strapping.— *Henry W. Lamb, M.D., Portland Maine.*

RECONSTRUCTION OF THE ANTERIOR CRUCIAL AND INTERNAL LATERAL LIGAMENTS OF THE KNEE JOINT. Maurice Horan. *Brit. J. Surg.* XIV, 569, Apr. 1927.

A series of eleven cases is reported. In each case the knee is approached through a J-shaped incision, the long arm being on the outer side, the curve below the tibial tubercle, and the short side on the inner aspect. The patella is split and holes bored through the external condyle of the femur and the internal tuberosity of the tibia. A strip of fascia lata one and one-half inches wide is turned down from the thigh and brought through the tunnel. The fascia is then carried through another hole drilled in the adductor tubercle, brought back and sutured to itself. The fascia thus replaces the anterior crucial and internal lateral ligaments.

Ten of the cases were examined from one to six years after operation. Satisfactory results were obtained in all,— sufficient improvement to allow the patients to return to ordinary labor.

Prolonged fixation following operation is avoided and no mechanical supports are provided.— *Ernest M. Daland, M.D., Boston, Mass.*

SOME OBSERVATIONS ON THE BONE. CHANGES IN RENAL RICKETS. E. P. Brockman. *Brit. J. Surg.* XIV, 634, Apr. 1927.

Three cases of juvenile interstitial nephritis with associated bone changes are reported. X-rays show changes in the region of the growth disc with a normal appearing epiphysis, an increase in the depth of the non-ossified area between the epiphysis and the diaphysis. Later there is bone absorption in this area, followed by extensive osteoporosis and dislocation of the epiphysis.

Necropsy in one case showed congenital cystic disease of both kidneys with chronic interstitial nephritis. The lower epiphysis of the tibia was displaced inward and separated from the diaphysis by a hemorrhagic area. The inner part of the shaft had been absorbed. The medulla showed an increase in the amount of fat marrow, the red marrow being displaced. There was little new bone formation, considerable bone absorption and replacement of the bone by fibrous tissue.— *Ernest M. Daland, M.D., Boston, Mass.*

ETIOLOGY AND PATHOLOGY OF CHRONIC DEFORMING ARTHRITIS. John V. Barrow and Eugene L. Armstrong. *Calif. and West. Med.* XXVI, 323, Mar. 1927.

Although this paper was written by internists, it contains valuable points for orthopaedic surgeons because of the fact that the authors cooperate very intimately with the orthopaedic service in the Los Angeles General Hospital.

The deformity produced in this disease is in the nature of bone destruction, compensatory hypertrophy, and spastic irritation. The pathologic changes in the joint indicate that the etiologic factor proceeds from the endarterial tissue of the marrow toward the periphery. Clinical and therapeutic evidence indicates that the gastro-intestinal tract is the most plausible source of the toxins or organisms of lytic destructive powers which produce these joint changes. It is believed that the disease is a general systemic one and that while the joint symptoms are the most outstanding signs, there are many other parts of the body affected.

Of the 245 cases forming the basis of this paper, 235 were gastro-intestinal cases first. Of these, 71.6 per cent. showed some abnormality of the bowels, such as constipation or diarrhoea. Protozoa were found in the intestinal tract in ninety-four per cent. of the whole group of cases. In only two cases did the disease begin after acute tonsillitis; in thirteen cases after influenza and in the remainder, no history of acute infection of any kind could be obtained. Eighty patients had had all their teeth removed before coming under observation by the authors and in none had this procedure stopped the course of the disease. Tonsils had been removed in sixty per cent. of the group with relief in only one case. Seventy-five patients had normal tonsils; eighteen, diseased. Only ten had bad teeth. In the course of the treatment, septic tonsils and teeth were removed but their removal made no striking difference in the progress of the disease.

The joints affected in the order of their frequency were fingers and hands, knees, spine, ankles, hips, elbows, shoulders, wrists, sacro-iliac, feet and toes.

The treatment may be classified as (1) parasitic, and (2) physiologic. The first consists in injections of emetin hydrochloride, 0.02, hyperdermically every other day, every third dose intravenously over a period of three weeks, then twice a week for another three weeks, then weekly for a month or two. Salol-keratin coated ipecac pills are also given in many cases. Alcresta ipecac 0.4 in combination with calcium phosphate 0.25, is highly recommended, especially in cases with constipation. Dietary treatment failed to give results. The authors can not agree with Pemberton that glucose tolerance has anything to do with etiology or treatment.

Orthopaedic treatment is of no help if it makes no attempt to stop the cause of the pathologic condition.

In this group, 209 cases were fairly treated and 30.6 per cent. of these showed excellent results; 42.2 per cent. good results; 20.5 per cent. fair results.—*William Arthur Clark, M.D., Pasadena, Calif.*

CYST OF THE EXTERNAL SEMILUNAR CARTILAGE OF THE KNEE. J. A. Nutter and C. L. Blew. *Canadian Med. Assn. J.*, XVII, 555, May 1927.

A case is reported. A boy of sixteen had been disabled for a few days by a kick on this knee one year before. Four weeks before examination he began to complain of tenderness at the outer side of the joint aggravated by walking. Examination showed a tense swelling in this situation, on the joint line, in front of the external lateral ligament. There was some pain on full flexion and extension. At operation the cartilage was removed. The tumor was embedded in it. It measured four by three centimeters, was polycystic in character, and contained a pinkish gelatinous material. Microscopically there were numerous small cysts. The walls were composed of fibrous tissue, and there was no mesothelium lining. When the patient reported ten months after operation, he had made a complete recovery.

The authors review the clinical features of the twenty odd cases in the literature. Their case is a typical one. They state that meniscotomy is necessary to effect a cure. —*A. P. MacKinnon, M.D., Winnipeg.*

HELIOTHERAPY IN RELATION TO THE TREATMENT OF TUBERCULOSIS OF THE SPINE IN CHILDREN. Ralph K. Ghormley. *J. Am. Med. Assn.*, LXXXVIII, 289, Jan. 29, 1927.

Paper based on sixty-three cases treated at the New England Peabody Home for Crippled Children, Newton Center, Mass.

*Progress records:*

1. Spine tracings made at six weeks' intervals.
2. Weight chart, record made monthly.
3. Anteroposterior and lateral x-rays at four months' intervals.

*Fixation:* By means of a split plaster jacket applied on a Goldthwait frame. This permits removal for heliotherapy and supports when the child is permitted up for play.

Deformity is improved when possible and may be expected when the case is treated early and involves the lumbar and lower dorsal regions.

*Effect of Heliotherapy:* Combined with rest and good food results in increased resistance, gain in weight, and hastening of calcification in the diseased bone. Patients are notably better at the end of the summer period with sixty-three per cent. of sunshine, than they are following the winter period, which at Boston has only forty-eight per cent. of possible sunshine hours. Artificial quartz light therapy is substituted on cloudy days, but is of doubtful value.

The author stresses the importance of the weight chart, deformity tracings and roentgenograms.—*W. B. Carrell, M.D., Dallas, Tex.*

SPRAIN OF CERVICAL SPINE CAUSING THROMBOSIS OF ANTERIOR SPINAL ARTERY. Roy R. Grinker and Chester C. Guy. *J. Am. Med. Assn.*, LXXXVIII, 1140, Apr. 9, 1927.

The authors make a complete report of a slight sprain of the cervical spine caused by yawning and stretching his arms, in a boy of fifteen. There was immediate pain and soreness, followed in an hour by loss of motion in his arms, and twenty minutes later complete paralysis in both legs.

X-ray negative. Neurological symptoms were those of a lesion of the cord at the fifth cervical vertebrae.

Paralysis continued until death from pneumonia thirty-two days after the injury.

*Autopsy Findings:* Thrombosis of the anterior spinal artery, with softening and disintegration of the anterior portion of the cord supplied by this artery.

No evidence of fracture or dislocation. The explanation of this lesion is that a temporary subluxation compressed the superficially placed anterior spinal artery, damaging the arterial wall and the resulting stasis permitted the thrombus to form.—*W. B. Carrell, M. D., Dallas, Tex.*

LEUCOCYTOSIS ACCOMPANYING FRACTURES. Ralph W. Walton. *J. Am. Med. Assn.*, LXXXVIII, 1138, Apr. 9, 1927.

The average leucocyte count in a series of 260 cases was 12,255, chiefly polynuclear, and highest in skull fractures, multiple fracturing and with extensive soft tissue involvment.

The elevation comes immediately after the injury, reaches a maximum in twenty-four hours and approaches normal after five or six days.

Faulty or delayed approximation increases and prolongs the leucocytosis.

The elevation of the white cell count appears to be influenced by three conditions: injury to bone and periosteum, injury to soft tissue and displacement of fragments.—*W. B. Carrell, M.D., Dallas, Tex.*

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PREVENTION OF CONTRACTURES FOLLOWING INFECTIONS OF THE HAND. Sumner L. Koch. *J. Am. Med. Assn.*, LXXXVIII, 1214, Apr. 16, 1927.

When incisions for drainage are made, great care must be exercised to avoid tendons, nerves, or vessels.

Dressings must be done with good technique to prevent contamination.

Streptococcus infection of the tendon sheath will usually heal without permanent drainage, but staphylococcus contamination leads to extensive sloughing.

Hot, moist dressings should not be continuously applied for longer than forty-eight hours. Movements of the hand and fingers are begun with subsidence of the acute process.

Physiotherapy measures as baking, massage, combined with splintage designed for constant pull against deformity, are useful.—*W. B. Carrell, M.D., Dallas, Tex.*

ANTERIOR SUBLUXATION OF THE ATLAS. W. A. Oppel. *Lancet* I, 698, Apr. 2, 1927.

In cases of anterior dislocation of the atlas where the ligamentum cruciatum remains intact the usual history is one of sudden death due to rupture of the cruciate ligament from trauma.

A case is related.

Male, aged thirty, admitted to hospital August 1926. On January 25, 1925, patient was carrying a weight of 200 pounds up a staircase. He noticed something crunch inside his neck but worked for two hours longer, when he experienced violent pain in the neck. He was taken to a hospital and the condition diagnosed as tuberculosis of the cervical vertebrae. Extension and plaster were applied for three months when he resumed his work. In February 1926 pain in the neck became worse. He had one week's treatment for strain of the cervical muscles. In July and August 1926, the condition became worse and he was admitted to hospital.

On admission, the head was held slightly to the right and was displaced forward. Examination through the pharynx permitted palpation of the anterior arch of the atlas. An x-ray showed the anterior arch of the atlas broken off.

*Operation.*

A plaster bed was prepared embracing one side of the head, the shoulder girdle, the shoulder itself and the body as far as the margin of the ribs.

On October 25, 1926, an incision was made along the posterior border of the sternomastoid. The accessory nerve was sacrificed. The retropharyngeal space was opened. Difficulty was experienced in chiselling through the anterior arch of the atlas, but this was successfully done and the anterior arch removed.

The patient remained in the plaster bed for ten days. After this he moved the head with increasing freedom. Photographs of the patient six weeks after operation showed that all the movements of the head had been restored.

The history of this case seems to suggest that results are obtainable by operation which are not achievable by more conservative methods.

Comment by letter on this article indicates disagreement with Oppel's reasoning, and suggests that laminectomy or "slinging the posterior arch of the atlas to the tunnelled spine of the axis by strong fascial grafts" would be preferable procedures.—*A. Gibson, F.R.C.S., Winnipeg.*

LIGHT TREATMENT IN SURGICAL TUBERCULOSIS. Sir Henry Gauvain. *Lancet* I, 754, Apr. 9, 1927.

The sun does not cure all forms of surgical tuberculosis. At the best it is merely an aid to and acceleration of cure. By the majority general treatment by natural sunlight is considered the best form of treatment.

Tuberculosis may arise and develop in sun-cure stations in the Alps. Such cases may improve or heal up when treated at sea-level or by brine baths on the plains. No reasonable explanation of this has yet been offered. There is a great diversity of response in the individual being treated. The response is usually seasonal and is greatest in the spring and early summer, May and early June. Where cases cease to respond, transfer to shore conditions supplies a new stimulus, sea-bathing, spraying, paddling, cool sea breezes and assistance given by the altered character of the light produce a new acceleration. The cachectic non-pigmenting patient of low resistance will not do nearly so well

in the Alps as at home. By the use of "vita" glass, which must be kept clean, sun balconies can be used to provide exposure to light when, owing to cold or rain, exposure to the naked sun is impracticable. Artificial light may be installed to supplement natural light. In this way the principle of varying stimuli may be utilized.

There is also a daily variation in response, morning light is best,—possibly as immediately following the darkness.

The different responses in different individuals seem infinitely variable. Heliotherapy in surgical tuberculosis is more an art than an exact science.

There is a constant rise in the basal metabolism after a course of sun treatment. This is due to exposure to cold air, not to sunlight. This increased metabolism means ingestion, digestion and absorption of more food. With this goes a speeding up of repair in damaged tissues.

Pigmentation is a valuable indication of the utility of treatment for it has a protective function. As a rule a well pigmented patient can tolerate and benefit by longer exposures to light and cold air than a non-pigmenter, and the danger of error is diminished.

Local light treatment of superficial lesions is governed by entirely different rules of application. It is meant to produce a direct reaction to a definite stimulus, e.g. in lupus vulgaris. Local light is of value by its bactericidal effect, its thermal action and the local favorable inflammatory response.

If these inferences are correct, the search for a suitable artificial light of constant character and intensity is illogical. It is better to adopt the method of varying stimuli to produce optimum responses.

The psychological action of light is evidenced by the cheerfulness and vivacity of the suitably isolated subject. This is an interesting and valuable factor in light therapy.—*A. Gibson, F.R.C.S., Winnipeg.*

THE POSSIBILITIES OF OPERATION IN INFANTILE PARALYSIS. A. H. Todd. *Lancet* I, 864, Apr. 23, 1927.

*Indications for Treatment at Various Stages.*

During the first few weeks the most important indication is to place the muscles at rest. Plaster makes the most suitable splint. At this time electricity is harmful. At no time should its use be prolonged for more than a year. The promiscuous use of a faradic battery by ignorant parents and others is to be whole-heartedly condemned.

*Cause of Contractures.*

There are two causes.

(1) Unbalanced action of muscles.

(2) Gravity.

The first and most fundamental law of successful treatment is to protect the paralyzed muscles from overstretching. Day-splints and night-splints may be necessary for this.

*Indications for Operation.*

It is unwise to perform any operation within about three years of the onset of the attack, as recovery may take place in greater or less degree within this period. The only admissible operation within this period is simple tenotomy,—usually tenotomy of the tendo Achillis.

Later in the disease operative possibilities are:

(1) *Tendon Transplantation.*

The tendon to be transplanted should be that of a homologous group. It should be transplanted only if it is going to subserve in its new position a more important function than in its old position. It must belong to a muscle of adequate power.

Examples of helpful tendon transplantation are:—

(a) The substitution of a paralyzed calf muscle by the use of the peronei and the toe flexors.

(b) The substitution of paralyzed tibialis by the use of both long extensors of the toes.

(c) Transplantation of the biceps flexor crureus to assist the action of a weakened quadriceps.

(2) *Stabilizing Operations.*

An uncontrollable joint can be stabilized by the use of a hinged instrument or by producing bony ankylosis. The latter measure is useful in the foot, in the knee and in the shoulder joint.

Even where there is considerable paralysis of the thigh in addition to a flail foot, it is still worth while to perform a stabilization operation for the flail foot. The author's preference is for a combination of the methods introduced by Naughton Dunn and Hoke.

(3) *Myotomies and Capsulotomies.*

When proper use of splints has been lacking, contractures often occur, e.g. permanent flexion at the hip joints from long confinement to bed. In such cases open division of all the tense structures including the joint capsules is of great value. This method can be applied at the knee, hip and elbow.

(4) *Amputation.*

This is seldom required nowadays. It is well to remember that any patient can be made to walk somehow, provided that he has one good buttock, even though one limb be totally flail and the other be severely paralyzed. Flail paralysis *per se* is not an indication for amputation. Practically speaking the principal indication for amputation to-day is the presence of inveterate ulceration of the affected limb. Even so, thorough consideration should be given before the operation is advised.—*A. Gibson, F.R.C.S., Winnipeg.*

Fractures of the Limbs with Special Reference to Initial Treatment. M. Sinclair. *Lancet* I, 920, Apr. 30, 1927.

Each new fracture is a fresh problem and x-rays must be used at every stage, a mobile x-ray plant being essential. Segregation of fractures in institutions would be the best means of obtaining good results.

The initial treatment by immobilization is essential. This tends to prevent hemorrhage, further laceration of tissues, and shock. The force used for extending the limb should never be allowed to relax as by so doing the fragments are made to travel. As soon as early callus is seen, movement of neighboring joints will be considered. Angulations have to be guarded against until the union is solid.

In the lower limb first-aid treatment of all fractures above the ankle joint can be efficiently carried out by the Thomas splint. Details of the application of this splint under accident conditions are given with great fulness.

In the upper limb every fracture above the lower third of the forearm can be taken care of by the "swivel-arm" Thomas splint. This instrument differs from the Thomas knee splint only in that the ring is round instead of oval, and made to swivel at the points of attachment to side bars to which it does not lie obliquely.

The possibility of a nerve lesion should always be considered.

While callus is soft, correction of deformity can be brought about.

"It is impossible to conceal the reality that a great deal of restorable function is lost by lack of proper early attention and that subsequently countless cripples are produced whose only real enjoyment of life is to blackguard us as a profession or the institution in which they were treated."—*A. Gibson, F.R.C.S., Winnipeg.*

Unusual Cases of Poliomyelo-encephalitis. W. A. F. Collis. *Lancet* I, 927, Apr. 30, 1927.

Case 1. Boy, aged twenty-one months. Vomiting, convulsions, loss of sight for one week.

On examination: Total blindness; internal strabismus; constant, slow, upward and downward movement of eyeballs and eyelids. Rigidity of back and neck, reflexes normal, no paralysis. Temperature 104.6 degrees. C.S.F. pressure high, otherwise normal. Recovery associated with much irritability. Two months later reported change of temperature, now irritable.

CASE 2. Girl, aged twenty months. Vomiting, stiffness of back and neck two days. Temperature 101.6 degrees. Knee jerk absent on left side, left leg weaker than right. C.S.F. under pressure, otherwise normal. Four weeks afterwards, child was able to sit up. Irritable during recovery.

CASE 3. Boy, aged three and one-half years. Pains in back and limbs, inability to walk, irritability, five days. Temperature 99.6 degres. Knee jerks absent. Kernig sign positive. C.S.F. under pressure contained 0.3 albumin. Four days later parens of left deltoid. In hospital six weeks. Steady improvement. Left with intention tremor resembling paralysis agitans, most marked in the hands. Very emotional.

CASE 4. Girl, aged three and one-half years. Lethargy, marked stiffness of back and neck. Sudden onset three days previously. Temperature 101 degrees. Cried when touched. Kernig sign positive. Optic discs normal. Knee jerks present. Discharged as normal three weeks later.

In Case 1, most of the symptoms can be located in the mid-brain, e.g. the blindness and the eye movements. In Case 3, the subsequent tremor was the only symptom of mid-brain lesion. All the cases showed stiffness of the back and other meningitic symptoms. Treatment of these cases is largely symptomatic; lumbar puncture useful for relieving pain and stiffness of the back.—*A. Gibson, F.R.C.S., Winnipeg.*

ACUTE INFECTIVE OSTEOMYELITIS TREATED BY CONSERVATIVE METHODS. H. H. Brown. *Lancet* I, 928, Apr. 30, 1927.

An attempt was made to save the diaphysis by "thorough disinfection of the bone".

Boy, aged six, admitted June, 1921. Had fallen and bruised left tibia six days previously. Temperature 105. Pulse 160. Left leg swollen, red, acutely tender.

Operation: Incision along whole length of inner surface of shaft of tibia. Whole of diaphysis bathed in pus, periosteum everywhere separated. Pus was washed away, surface of bone and periosteum scrubbed with gauze soaked in 1 in 20 carbolic, then methylated spirit, then ether and packed off with gauze. The shaft of the bone was then opened freely for the whole length of the medullary cavity. The medulla was cleared away and the cavity of the bone similarly cleaned with carbolic, spirit and ether. Slips of gauze soaked in bipp were placed between the periosteum and the bone, and the cavity was also stuffed with gauze soaked in bipp.

The following day the temperature fell to normal and all oedema, redness and tenderness had disappeared. The gauze packing was removed after three days. The diaphysis retained its vitality and no involucrum was formed round it.

A small sequestrum about three-quarters inch in length was extruded from the upper end of the tibia.

At the present time the leg appears normal, except for the operation scar. A radiograph shows that the tibia is also normal in structure, and that there is no thickening or deformity.—*A. Gibson, F.R.C.S., Winnipeg.*

THE TREATMENT OF ACUTE SUPPURATIVE ARTHRITIS OF THE KNEE JOINT. Balcombe Quick. *Med. J. Australia.* XIV, 391, Mar. 29, 1927.

The article considers primary suppuration of the knee joint; and not the extension of an osteomyelitis. The problem is unusually taxing, because of the complicated anatomy of the knee joint, with its diverticula, making adequate drainage difficult; and because of the proximity of the popliteal vessels and nerves; and the masking by the popliteal fascia, of collections of pus anterior to it.

The solution of the problem of suppuration here, as elsewhere, depends upon the relief of tension by free and dependent drainage. With imperfect drainage only those recover who have high resistance and an infection of low virulence.

The knee joint is roughly divided by its contained structures, into an anterior, a posterior-internal and a postero-external compartment; and the two posterior cavities constitute the most dependent parts of the joint in the horizontal position—the regions which are the most important, and also the most difficult, to drain.

Eight methods of draining are discussed.

1. *By repeated aspirations,* with or without lavage or injection of antiseptic. An occasional case with infection of low virulence will recover by this method. Too long persistence in it is dangerous.

2. *Jaboulay's arthrotomy;* Incision of the suprapatellar pouch and slinging up the leg. K. Speed did a subcrureus drainage and inversion of the patient for two hours day and night with good results in four out of six cases.

3. *Parapatellar incisions;* Drain only the anterior pouch. Infection is never confined to the anterior alone.

4. *Anterior and posterior arthrotomy:* A valuable operation when well carried out. The anterior incisions follow the line of reflexion of the synovial membrane from the femur; the posterior are just internal to the semitendinosis and biceps tendons, respectively, the dissection then being carried through the posterior capsule, passing through this structure transversely and dividing parts of both heads of the gastrocnemius, and the popliteus tendon. Drainage tubes are usually passed through the incisions.

5. *Anterolateral arthrotomy:* A parapatellar incision on each side, met at a right angle by an incision along the joint line, dividing the lateral ligaments and the tendon of the popliteus. Both semilunar cartilages can be then removed and the postcondylar recesses drained by tubes. The mutilation of this procedure may be disregarded, since it is applicable to cases which would in any event become ankylosed.

6. *Transverse arthrotomy:* Parapatellar incisions, with a transverse incision through the anterior half of the knee in the joint line, followed by an opening up of the entire joint by flexion of the knee. The only connections remaining are the crucials and the posterior knee joint ligament. The fat pads and menisci are excised. The pouches behind the femoral condyles can now be readily explored and drained. Dakinization is instituted and dressings done at intervals of two to five or six days, under anaesthesia. The leg is gradually straightened and healing and ankylosis proceed.

7. *Excision of the knee joint:* This accomplishes nothing more than the preceding method and may lead to an osteomyelitis.

8. *Willems's method:* Drainage arthrotomy followed by free active movement. The results have generally been unsatisfactory.

The choice of a method depends on—

1. Duration of the infection.
2. Age and general resistance of the patient.
3. Type of infection.
4. The clinical picture after several days of the infection.

The milder the case, the less radical the procedure.

Method 1 may succeed in very early and very mild cases.

Methods 2 and 3 will usually require also the evacuation of collections of pus posteriorly.

Methods 4, 5 and 6 are of about equal value.—*Edward N. Reed, M.D., Santa Monica, Calif.*

JOINT TUBERCULOSIS. Russell A. Hibbs and Alan DeF. Smith. *Med. J. Australia* I, 810, June 4, 1927.

The general belief that joint tuberculosis nearly always starts in the bone and invades the joint secondarily, is probably untrue.

The study of the tissues from early operations on tuberculous joints at the New York Orthopaedic Hospital shows that in the knee joint, at least, the process usually begins in the synovial membrane, both in children and adults. The progress of the disease is probably slower when it begins in the synovial membrane than when it begins in the bone—and in these cases the diagnosis is very difficult during the first two years, and is often missed—until late in the disease.

The results of the difficulty in making an early diagnosis are:

(1) Many cases go untreated until so far advanced that a cure is difficult;

(2) Many non-tuberculosis cases are subjected to the discomfort and expense of the standard treatment for tubercular joints;

(3) Reports of the results of conservative treatment of tuberculous joints are unreliable.

It is the custom at the New York Orthopaedic Hospital, when a positive diagnosis cannot be made, to do an exploratory operation, and remove portions of synovial membrane for laboratory examination. The incision is then closed without drainage.

No suspected joint should ever be immobilized until a positive diagnosis is established. Immobilization soon produces muscle wasting, limitation of movement and decalcification of bone, which obscure diagnosis.

Heliotherapy does not, in the authors' experience, cure joint tuberculosis. Permanent cure is obtained only by absolute elimination of movement from the joint by arthodesis.

Hospitalized under the most favorable conditions for a period averaging six years, twenty per cent. of knee cases apparently recovered, with a fair range of motion. Hip joint cases showed much worse results. It is felt that so small a chance of recovery is not worth the sacrifice of such prolonged treatment to the average patient.

A spine can be fused at any age. The knee joint can be arthrodesed in all cases at six years,— in some at four. Arthrodesis gives seventy per cent. of cures in tuberculosis of the spine and between ninety and one hundred per cent. in knees. The average period of hospitalization has been reduced to eighteen months.— *Edward N. Reed, M.D., Santa Monica, Calif.*

TUBERCULOSIS OF THE INTERNAL EXTREMITY OF THE CLAVICAL. Louis Ménard. *Paris Méd.*, XVII, 48, Jan. 8, 1927.

Ménard reports a very complete series of observations of the localization of tuberculous lesions with radiographic control, also operative and bacteriological. He gives a complete history of the question, gathered from the more recent works.—*Jacques Calvé, M.D., Berck-Plage, France.*

MASCULINE OSTEOMALACIA. Chabrol, Haguenau and Le Grand. *Presse méd.*, XXXV, Mar. 2, 1927.

This is a final report of the case of Godezenne, the patient whose record has been given wide publicity through a series of reports published by Prof. Berger between 1899 and 1905. Dying in 1922, at the age of forty-six years, he had passed the last twenty-six years of his life as a practically helpless cripple in an institution at Ivry. Interesting as an instance of the comparatively rare masculine osteomalacia, this case is remarkable in that its evolution was toward healing rather than to rapid progression and fatality. Death was finally due to pulmonary involvement in grippe. From 1896, when at the age of twenty the onset of the bone disturbance was noted, decalcification proceeded rapidly for a period of two years, at the end of which followed a course of improvement in general condition and in the use of the limbs. Radiograms at this time, and later, show what is said to have been a tendency in the bones to recalcify. This remission continued through the rest of the patient's life. This fact of recalcification was confirmed at the autopsy in 1922. (It is not stated why this autopsy report has been delayed so long in publication.) The bladder contained large concretions of calcium carbonate. The hypophysis showed few changes in structure. Active spermatozoa were found in the testicles. Some degenerative changes were determined in the thyroid bodies, with sclerosis of the interstitial tissues. The most significant changes were noted in the suprarenal glands which were much increased in volume. In both the cortical zone was rich in lipoids and took a sharp orange-red stain with Soudan red; the medulla was hyperplastic. These latter findings seem to justify those who have believed osteomalacia to be consequent on a disturbance of the function of the suprarenal glands. —*Roades Fayerweather, M.D., Baltimore, Md.*

WHAT EVERY RADIOLOGIST SHOULD KNOW ABOUT BONE TUMORS. Joseph C. Bloodgood. *Radiology*, VIII, 195, March 1927.

The paper discusses the relative effectiveness of curetting, with thermal and chemical cauterization, and of radiation, on the one hand, and amputation or resection, on the other, in various bone tumors.

It has become agreed that giant-cell tumor is not sarcoma and that thorough curetting with thermal and chemical cauterization, will cure just as well as amputation; or resection done where the mechanical indications called for it.

The author has never seen radiation followed by complete ossification of a central tumor in the epiphysis. Operation following radiation continued as long as one year, has never shown any ossification of the soft tumor mass. Thorough curettement, with thermal and chemical cauterization should cure in every case, in the shortest time, with the best functional result. If the bone shell is intact, immediate curettement should be done. If the shell is partially destroyed, radiation may first be tried, but the ultimate cure is most quickly accomplished by curettement.

Radiation is followed by temporary increase in pain, swelling and oedema: these disappear and there occurs a definite contraction of the expansile tumor, and, in a very few cases ossification of destroyed areas in the bone shell.

Radiation is much better than biopsy unless immediate diagnosis can be made by frozen sections at time of operation.

The common tumor of epiphyses of long bones is the giant-cell tumor: but there may be chondroma myxoma, chondromyxosarcoma, unhealed bone cyst, a single caseous tuberculous area or a Brodie abscess. These also are best treated by curettement with thermal and chemical cauterization.

In tumors of the phalanges, metacarpals and tarsal bones, and in central tumors of the lower jaw, curettement before the bone shell has been destroyed is the ideal treatment.

Central tumors of the shaft of long bones in children and adolescents are usually due to osteitis fibrosa or bone cysts and are cured by operative production of a fracture with crushing in of the bone shell; the tumor first having been explored and its pathology established.

Shaft tumors in adults are less frequently cysts, and may be chondroma, myxoam or sarcoma: or a metastatic lesion, or multiple myeloma. Nothing is gained by radiation, if the shell is intact. The tumor should be explored and the proper surgical procedure determined by its nature, location, and the extent of involvement of the shaft.

It is very difficult to determine, from radiograms, the nature of single lesions destroying the marrow cavity in the shaft or the cancellous bone in the epiphyses or flat bones. Where there is bone formation outside the shell, this suggests a chondroma, chondrosarcoma or metastatic tumor.

It is impossible to tell whether some lesions are central or periosteal in origin: they are diffuse. Such are sclerosing sarcoma and sclerosing osteomyelitis. In these, biopsy is the diagnostic method of choice, where resection or amputation is contemplated.

There is another diffuse lesion, an osteoporosis, sponge-like in appearance, with some periosteal thickening: most of these are sarcomas of the so called Ewing type; some are metastatic carcinomas.

In malignant disease, choice must be made between radiation and amputation. If radiation is chosen, there should be no biopsy. If amputation or resection is chosen, it should immediately follow biopsy. Practically the only cures of bone sarcomas have followed amputation below the upper third of the femur. Elsewhere, the indications are for resection or radiation.

The author reports one case of diffuse sarcoma of the upper shaft of the humerus remaining well six years after radiation. Two cases with questionable diagnosis remained well after radiation only, for almost five years. Except these, of many bone sarcomas persistently radiated none showed definite cures. Myxomas and chondromas have shown no results from repeated and prolonged radiation. Temporary cures but none

permanent, have followed radiation of Ewing's type of sarcoma; no effect in multiple myeloma: nor in bone metastases from hypernephroma.

In metastatic carcinoma in vertebrae there has usually been immediate relief of pain, and restoration of function: in a few, ossification of destroyed vertebrae.

There is an increasing number of five-year cures following amputation for sarcoma below the upper third of the femur: since 1918 the percentage of cures has risen from less than eight to more than twenty. There is one five-year cure after amputation of a sarcoma of the upper extremity. In the past three years the author has resected four very early sarcomas of the upper extremity: these are apparently well and have good function. These early diagnoses were impossible from the radiograms and were made by biopsy.

The danger from biopsy is the interval of time between exploration and the resection or amputation. Either the diagnosis should be made from frozen sections, followed immediately by operation; or thermal and chemical cauterization used in the exploratory operation, and the wound packed with gauze wet with fifty per cent. zinc chloride solution and the skin closed over it, when a lapse of a few days to a week is safe.

In case of doubt as to malignancy, the lesion should be treated as benign, since the element of error favors innocence, and the probability of curing malignancy is too small to justify amputation or resection without certainty.—*Edward N. Reed, M.D., Santa Monica, Calif.*

EXOSTOSIS. Henry W. Meyerding. *Radiology*, VIII, 282, Apr. 1927.

Exostoses are grouped with the benign osteochondromas. From the x-rays can be determined the diagnosis; size, shape and position, and the progressive growth and structural changes. The author believes that heredity and metabolic changes in childhood are among the more important, and trauma a less important etiological factor. Seventy-nine and seven-tenths per cent. of exostoses and seventy-five per cent. of sarcomas occur between the ages of eleven and forty years.

The symptoms are usually painless swelling or deformity with mild tenderness on deep pressure; occasionally dull, steady, localized pain. Blood examination, Wassermann, and urinalyses were usually negative.

The exostoses were widely distributed. The lower ends of femur and tibia, the upper ends of humerus and tibia, are the favorite sites, in the order named. Sarcoma has a somewhat similar distribution. The cortical point of origin is usually in the diaphysis near the epiphyseal line. The mass is pedunculated or sessile. The cortex may appear continuous with that of the tumor and medullary bone may be continued into it. Cartilage usually caps the head and often presents a cauliflower-like appearance. A bursa covers the well formed tumors. There is no invasion of surrounding tissues. Bone is not absorbed, except as the tumor causes pressure on neighboring bone. The periosteum covering the tumor is normal. Growth is usually away from the joint.

Treatment is operative removal, if the tumor is causing deformity, inconvenience or pain. Excision, with snug layer closure to prevent hematoma, is usually sufficient. Cauterization or postoperative radiation may be used to insure against recurrence. The bursa and all cartilage must be excised, preferably *en masse* with the tumor.

The prognosis is good; recurrence in about ten per cent. Six case histories and a number of excellent x-ray illustrations are presented.—*Edward N. Reed, M.D., Santa Monica, Calif.*

BONE DISEASES IN INFANTS AND CHILDREN. Philip Lewin and Edward L. Jenkinson. *Radiology*, VIII, 409, May 1927.

RICKETS: The irregularity and haziness of the epiphyseal line, the softening and mushrooming of the epiphysis, and the saucer-shaped deformity of the diaphyseal line are described.

SCURVY: A rare disease at this age, because most infants are fed fruit juices. The

characteristic change is "Trommer's line", an area of decalcification, appearing like a second epiphyseal line, just behind the diaphyseal line. The epiphyseal line, epiphysis, and joint spaces are normal. The periosteum over Trommer's zone is stripped by hemorrhage. The gums and teeth also show changes.

LUES: The changes occur, in order of frequency, in the lower ends of femora, ends of tibiae, distal ends of ulnae, radii and metacarpals; but may involve any bone, and are usually multiple. There is a sclerosis of bone at the epiphyseal line, and the zone of provisional calcification is much wider than normal. The epiphysis and epiphyseal line are normal, the characteristic changes being located at the diaphyseal line, showing irregular, gouged-out areas. The shafts show thickening of the cortex, on the convex side, and usually thickening of the periosteum. Also thickening of the periarticular tissues and fluid in the joint cavities. Deformities are common and often extreme; fractures rare.

TUBERCULOSIS: Haziness of the joint space, narrowing, bone atrophy and bone destruction are characteristic of tuberculosis. Bone production may occur under three conditions: secondary infection, calcification of an exudate, or periosteal involvement. Phemister states that in pyogenic arthritis the cartilage is destroyed first at the points of contact and greatest pressure of opposing surfaces; in tubercular arthritis, regions not in contact are first destroyed.

NON-TUBERCULOUS EPIPHYSITIS: The epiphysis becomes rarefied and shows multiple small areas of bone destruction. In contrast to tuberculosis, the outlines of the bone are sharply defined. No abscess formation as a rule. There is often bone production and bony ankylosis, differentiating the disease from Legg-Calvé-Perthes' disease; also the process often spreads through the articular surface and involves the acetabulum. The diaphyseal line may become involved and later ossify. Epiphyseal separation is often seen, but the shaft is not involved.

LEGG'S DISEASE: The etiology is unknown. The head and neck of the femur is the most frequent location—usually unilateral. The bone outlines are sharply defined, in contrast to tuberculosis. The head softens and the neck widens. With continued weight-bearing, the head flattens. The pelvic bones on the affected side may be atrophied. The disease is self limited: one year of softening, followed by two years of hardening and rebuilding. The head rebuilds its structure rapidly. Permanent deformity of the head may result if weight-bearing is allowed during the stage of softening. The condition has been seen in the lower femoral and upper humeral epiphyses, and in the lower tibial and fibular epiphyses. The following group of conditions have many characteristics in common, viz: Legg-Perthes' disease; Osgood-Schlatter's disease; Köhler's disease; Freiberg's infraction of the metatarsal heads; apophysitis of the os calcis, Scheuermann's kyphosis dorsalis juvenilis; and Calvé's vertebral epiphysitis.

OSTEOMYELITIS: The favorite site in the haematogenous type is at or near the diaphyseal line; especially in the upper tibia and lower femur. The epiphyseal line is crossed and the joint involved in the more severe cases. In the traumatic type the disease may begin in the shaft; starting in the medulla, the disease penetrates the cortex and finally involves the periosteum. X-rays help very little in the early diagnosis of osteomyelitis. The first radiographic sign is thickening rather than absorption. In the differentiation between malignancy and infectious lesion: in osteomyelitis, areas of normal bone are often found between areas of destruction, unless the infection is very virulent; in malignancy this is not true. Malignant disease never produces sequestra; nor does it pass through a joint, as osteomyelitis sometimes does. New bone produced by osteomyelitis is laid down parallel with the shaft; in malignancy, perpendicularly to the shaft.

ARTHRITIS DEFORMANS IN CHILDREN, OR STILL'S DISEASE: probably develops from a focal infection, often tonsillar. The X-ray findings are not very characteristic.

In the coccidioidal granulomata, neither the soft tissue nor the bone lesions can be distinguished from tuberculosis except by bacteriological methods.—*Edward N. Reed, M.D., Santa Monica, Calif.*

BIOPSY IN DIAGNOSIS OF MALIGNANCY. Joseph C. Bloodgood. *South Med. J.*, XX, 18, Jan. 1927.

These statements are based upon his very large personal experiences since 1893 and upon the records of the Johns Hopkins Hospital. Small lesions and tumors of the skin should be completely removed without biopsy. The danger of incomplete removal is settled. The danger of biopsy when necessary with an interval of time is not proved. Small subepidermal, subcutaneous, subfacial, and intermuscular tumors are not infrequently malignant. Five per cent. of dermoid cysts are malignant. Lesions of the lip, tongue, gums, oral cavity are preferably excised, or a biopsy done with immediate frozen section diagnosis. Biopsy in lesions of bones: We have not a sufficient number of sarcomas of bone living five years after operation to estimate whether biopsy previous to amputation or resection adds to danger of metastasis. Biopsy in lesions of bone at present is essential in some cases. If there is danger in properly performed biopsy, it is danger that we must incur rather than perform mutilating operations, such as amputations, extensive resections, etc. The importance of having a properly trained pathologist in the operating room is stressed. Myxoma of bone is apparently the most transplantable of known tumor tissues in the human. This article also discusses biopsies in breast tumors, cancer of the uterus, parotid, salivary and thyroid tumors. Biopsies should be made with thermal and chemical cauterization for protection and immediate frozen section diagnosis made by a competent pathologist. This article is the result of intensive study by a man of wide experience and should be carefully read in its entirety. No abstract can do it justice.—*F. G. Hodgson, M.D., Atlanta, Ga.*

TYPHOID OSTEITIS: REPORT OF TWO CASES. Chas. C. Garr. *South Med. J.*, XX, 296, Apr. 1927.

This osteitis, a complication of typhoid fever, may occur during the febrile stage, during convalescence, or may follow many years after the original disease. In one of the cases here reported the bacillus was found in the bone abscess twenty-seven years after the original attack. There are three types of bone involvement: (1) circumscribed osteitis, (2) suppurating osteomyelitis, (3) collar button abscess. After operation or rupture, sinuses are apt to persist a long time. Pure cultures of B. typhosus, may be obtained from these sinuses; rarely mixed infection is found. Typhoid vaccine is almost a specific in the treatment of this condition. Two cases are reported in detail.—*F. G. Hodgson, M.D., Atlanta, Ga.*

SOME ASPECTS OF THE PROBLEM OF JOINT TUBERCULOSIS. Russel A. Hibbs. *South Med. J.*, XX, 278, Apr. 1927.

An end-result study was made of cases which had been under observation for from five to fifteen years. Of seventy-seven cases of knee joint tuberculosis, thirteen per cent. were incorrectly diagnosed, seven died of other forms of tuberculosis, forty-three became quiescent, sixteen again became active,—of the remaining twenty-seven cases, five had stiff joints, twenty-two had varying degrees of motion, sixteen cases had fusion operations and have remained free from symptoms. The result of conservative treatment of tuberculosis of the hip was still worse; 208 cases were treated. Twenty-two per cent. were incorrectly diagnosed, leaving 162 cases with probable tuberculosis. Twenty-four per cent. died; of the 144 remaining cases seventeen are still active; two are quiescent with probably free motion; forty-one are quiescent with marked limitation of motion and varying degrees of deformity; fifteen cases had relapses after varying periods of quiescence. Average duration of treatment was seven and three-tenths years. More than eighty fusion operations have been performed with a high percentage of cures in those in which a sufficient length of time has elapsed to make any judgment possible. Relapses occur in tuberculous joints, ten, fifteen and twenty years after treatment has been discontinued and the cases have been classified as cured. The terms "quiescent" and "cured" have been inaccurately used. The condition of the general health is no guide. He says there is no evidence yet to prove that heliotherapy has any particular

influence upon the progress of the disease, and there is grave danger that the belief that it has, which is so generally accepted, may delay the proper study of this disease for another decade.—*F. G. Hodgson, M.D., Atlanta, Ga.*

TREATMENT OF ACUTE COMMINUTED FRACTURES ABOUT THE ELBOW JOINT: Report of Sixty Cases. H. Earle Conwell. *South. Med. J.*, XX, 579, Aug. 1927.

This deals only with the severe cases where the usual Jones acute flexion method is not practical. There were forty-eight simple fractures and twelve compound fractures. There were fifteen positive Wassermann reactions immediately after injury, but twelve of these were negative a few days later. All were admitted to the hospital, x-rays taken and immediate manipulation and reduction under anaesthesia. Adhesive traction and suspension to forearm, and adhesive traction and lateral splints to the upper arm. A special traction abduction frame is attached to the bed holding the arm at ninety degrees of abduction and the forearm flexed and suspended. From four to twelve pounds traction on upper arm. Just enough weight on forearm to allow elbow to rest gently on abduction board. The elbow is flexed only about ninety degrees until the swelling subsides, then gradually increased from day to day. Active motion is allowed as soon as the patient can be persuaded to carry it out. Ether and Dakin's solution are used to cleanse compound wounds. Following the removal of supports, hot baths, massage, active and passive motions and diathermy are used. Daily inspection and radiant light are used while cases are in the hospital. No forced motions are used. Let the patient do all the work. Excellent results have been obtained. There were forty-five excellent results, ten fair, and only five ankylosed. Good detailed drawings, and photographs of the method are shown.—*F. G. Hodgson, M.D., Atlanta, Ga.*

FRACTURES OF THE UPPER THIRD OF THE ULNA. Isidore Cohn. *South. Med. J.*, XX, 585, Aug. 1927.

Accurate reduction of these fractures is important on account of the carrying angle, and the function of the elbow joint. If the reduction can not be accomplished by manipulation, an open reduction is indicated. An incision is described for approaching the upper third of the ulna and the elbow joint. This article is well illustrated and numerous radiographs shown.—*F. G. Hodgson, M.D., Atlanta, Ga.*

OPEN REDUCTION OF FRACTURES OF THE FOREARM. Arthur M. Shipley, *South. Med. J.*, XX, 595, Aug. 1927.

In fractures of both bones of the forearm when satisfactory reduction has not been obtained by manipulation, the writer advises open reduction. The ends of both bones are exposed by incision; the ends of the bones are forced together. No sutures, wires, or plates are used. The sutured ends will hold together. Old unreduced Colles' fractures are also treated by open operation.—*F. G. Hodgson, M.D., Atlanta, Ga.*

REVIEW OF OVER TWO THOUSAND FRACTURES IN PAST SEVEN YEARS. E. Dunbar Newell. *South. Med. J.*, XX, 644, Aug. 1927.

In 2374 cases there were only sixty-four open operations. There was only one case of non-union. This was in the radius. One case of delayed union in tibia lasted over two years but finally was firmly united after wearing an ambulatory brace. One case of fracture of both bones of the forearm developed Volkmann's contracture in spite of careful attention. Fractures of the patella were usually operated upon. Early reduction, and early massage and manipulation are stressed.—*F. G. Hodgson, M.D., Atlanta, Ga.*

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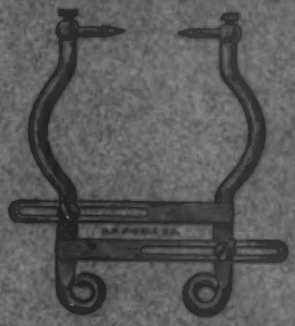

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